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ABSTRACT

The Tomas Rivera Policy Institute conducted research to clarify the state of technology development in schools in San Bernardino and Los Angeles counties, California and to determine whether meaningful technology access was out of reach for those school districts in which the enrollment was predominantly Hispanic. The empirical investigation, with surveys completed by 54 principals and 123 teachers and interviews with 12 administrators, and case study site visits show that instructional technology is currently beyond the grasp of many Hispanic youth enrolled in California's public K-12 schools. In the school districts studied, the student-to-computer ratio of 14 students for every 1 computer was not significantly different from the state as a whole. However, Hispanic districts were significantly less likely than non-Hispanic districts to receive assistance from school administrators when it came to supporting technology development, in part because the administrators in Hispanic districts perceived many issues to be more significant. Teachers in the Hispanic districts were also more concerned with security and more likely to reduce student access to computers. The research concludes that students lack the tools to compete in today's marketplace, since a working knowledge of information technology is necessary for the majority of new jobs. Aspects of technology development that must be considered in addition to the mere number of computers are professional development, administrative and staff support, and environmental factors in the schools. Public and private sectors in California need to unite to improve access to educational technology for all students. Appendixes present profiles of participating school districts, a list of sites visited, and a list of interview participants. An attachment discusses study methodology. (Contains one table and nine figures.) (SLD)

OUT OF REACH?

Latinos, Education and Technology in California

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OUT OF REACH?

*Latinos, Education and
Technology in California*

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Foreword

The Tomás Rivera Policy Institute's ongoing research on the opportunities and obstacles facing the Hispanic community in the information age has uncovered many "artifacts" that have heretofore been buried. The TRPI was the first to dust off the conventional wisdom about computer access (that Hispanics do not buy computers principally due to income) to reveal a much more complex dynamic at work.

This report is the latest in a series whose purpose is to explore further how Hispanics are faring in terms of access to information technology. The pages that follow examine the state of educational technology in California's K-12 public schools. The TRPI addresses this issue within a broader definition of access, one that comprises qualitative as well as quantitative indicators. After all, is not having a teacher who can integrate computers into the curriculum and teach with them effectively just as important as having a multimedia computer in the classroom? In outlining these qualitative aspects of technology access, such as professional development, the TRPI goes beyond conventional quantitative comparisons of technology to delve into the meaningfulness of this access. Such a study provides a richer picture of computer access in the schools with which we can begin to answer the question: Is high quality technology, fully integrated into the learning environment, out of reach for a preponderance of Hispanic youth?

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This report would not have been possible without the full cooperation of the teachers, principals and administrators whom we surveyed and interviewed. Many instructors and administrators spent a considerable amount of time with us, helping us to understand the state of educational technology in their respective school or district. For this, we are grateful.

The research design, especially the questionnaires sent to teachers and principals, was greatly improved through feedback from Dr. Dale Berger at the Center for Organizational and Behavioral Sciences at the Claremont Graduate School (CGS). Our interview questionnaire and techniques were fine tuned through the help of Dr. Jean Schroedel in the Center for Politics and Economics at CGS.

Thanks to my colleagues at the Tomás Rivera Policy Institute (TRPI) for examining earlier drafts of this report: Anoop Bhargava, David De Luz, Dennis Falcón, Kathy Gumbleton and Luis Plascencia. Also assisting on the project at one time or another were Anne Larson, Morgan Appel and James Bayrer.

In particular, I would like to thank our friends at GTE, Jorge Jackson and Elva Lima, without whose support this project would not have been possible.

Executive Summary

When it comes to understanding the gap in technology access between Hispanic and non-Hispanic students, much of the previous research in this area focused on quantitative data, such as the number of students per computer or the number of **Internet** (terms in bold print are defined in glossary) connections in a given school. This Tomás Rivera Policy Institute (TRPI) report suggests that educators and policy makers also need to take account of qualitative factors that comprise technology access. Qualitative indicators are those aspects of technology development that cannot be easily quantified but which are nonetheless crucial to the success of instructional technology in the classroom. What is the value of a stand-alone, outmoded computer that sits broken in the corner of a classroom? This computer counts when teachers are asked to fill out the number of computers in their classroom, but what is its value in enhancing the learning environment of students?

Visiting K-12 public schools in Southern California and conducting extensive in-person interviews, the TRPI discovered that many factors impact students' access to technology beyond how many computers are present in the classroom. The aspects of technology development brought to light in this report include:

professional development—rapid changes in technology mean that teachers are often playing catch up in learning the latest computer applications. Educational institutions are directing more attention to the professional development and training of staff members, without which computers will likely be used ineffectively, if at all.

administrative and staff support — there are many leaders both at the school district and individual school level who believe there are more important issues facing students than whether they

become computer literate. If administrators are not convinced that technology is a worthwhile investment, then many scarce resources will flow elsewhere. Also, if staff persons are not accepting of technology in the classroom, then the chances will be slim that they will use it to enhance curriculum.

environmental factors — a great number of schools are in disrepair, lacking the infrastructure needed to support an enhanced technology environment. In addition, many schools are concerned about security, such as protecting their computers from theft and vandalism.

To complement its site visits and in-person interviews, the TRPI conducted other qualitative and quantitative analyses in selected K-12 schools. Examining state-level Census data and original survey research on technology development in 22 school districts in Los Angeles and San Bernardino Counties, the question was posed: Are computer technologies further out of reach for Hispanic children than for non-Hispanic students?

Our empirical investigation and case study show that instructional technology is currently beyond the grasp of many Hispanic youth enrolled in California's public K-12 schools. Based on the empirical findings, the TRPI concludes that students lack the tools to compete in today's marketplace, since a working knowledge of information technology is necessary for the majority of new jobs. The basic policy recommendation following from this analysis is that all students need meaningful access to quality instructional technology, such as Internet-based activities and **interactive multimedia**. This requires a massive up-front investment in our children which would undoubtedly yield future returns through the preparation of a labor force that would be more highly educated and more productive.

To summarize the empirical findings:

- Among the school districts in Southern California which the TRPI studied, the student-to-computer ratio of 14 students for every one computer was not significantly different from either Los Angeles County (14:1) or the state average of 16 students per computer.

When we go beyond computer penetration rates and examine the quantitative indicators that comprise technology access (some of which we have described in this summary), gaps exist between the schools which TRPI surveyed with a majority-Hispanic population and the district which is primarily non-Hispanic in the following areas:

- Hispanic districts were significantly less likely than the non-Hispanic district to receive assistance from school administrators when it came to supporting technology development in the schools, in part due to the fact that administrators in districts with a large Hispanic enrollment perceived other issues to be more pressing than introducing more technology into the curriculum.
- Teachers in Hispanic districts perceived the security of their equipment as a more pressing con-

cern than teachers in the non-Hispanic district, with the effect of preventing students from receiving greater computer access.

The major policy recommendations that are derived from the data analysis include the following:

- California's political, corporate and philanthropic leadership must be mobilized to raise the public and private revenues to fund massive technology infrastructure development, particularly in those districts in which instructional technology is least developed.
- Parents, community members and educators must advocate strongly for comprehensive educational technology investment in their schools and convince policy makers that technology is an essential component of preparing children for the 21st Century.

To compete in the global marketplace, California must invest in information technology, including providing school children and instructors with the infrastructure, skills and training which will lead to full participation in the new economy. This report finds that public and private actors in California need a wake up call in order to guarantee a bright future for the Golden State.

1. Introduction

What is occurring in California's public K-12 schools today with regard to technology development is analogous to the Greek myth of Tantalus. Tantalus was condemned to stand in a pool of water that receded whenever he tried to drink and with fruit dangling above him that was forever out of his reach. Like the tragic Greek figure, many teachers, principals and administrators continue to feel that a **technology-rich learning environment** is out of their reach. As much as they try to bring the latest hardware, software and pedagogy to their students, certain obstacles (which this report illuminates) prevent educators from realizing their goals. Unlike the myth of Tantalus, however, school districts can overcome their fate, if policy makers and educators, in concert with the private sector, take action to rectify these problems.

One might wonder why it is necessary to highlight technology access in the schools at this time? It is now virtually indisputable that computer networks represent a "universal currency" with which persons will communicate, exchange wares, and seek out information across traditional borders. A report recently released by the Tomás Rivera Policy Institute (TRPI) found that K-12 schools were the central gateway through which Hispanic youth could gain **computer literacy**.

There is near consensus that computer literacy is vital in order for most persons to succeed in the new economy. According to a recent Michigan State University survey of 525 businesses, industries and governmental agencies, new college graduates need not apply as new hires without computer literacy and computer skills. Manipulating and mastering computer applications thus is essential for employability and a better quality of life.

A U.S. Department of Labor study found, moreover, that Hispanics will add about 6.5 million workers to the labor force from 1992 to 2005. Virtually all of these workers will be seeking jobs

in the service-producing industries, such as health, education and business services, jobs that require high levels of education and computer training. Indeed, approximately 60 percent of new jobs require a working knowledge of information technology. Ensuring meaningful access to these tools to all persons via the public schools—particularly minority students and children in poverty—must be a high priority for any society that wishes to compete successfully in a technology-intensive, global marketplace.

The Public-Private Interface

The public and private sectors in the United States have been building a national information infrastructure (NII). This so-called "information highway" can be described as "the physical facilities used to transmit, store, process, and display voice, data, and images" as well as the means to integrate and interconnect these physical components.¹ It is anticipated that the NII will provide economic and social benefits to those who have meaningful access.

While the private sector has been doing much of the rowing—that is, constructing the **broadband links** that will connect all homes and institution to each other—the public sector continues to steer, when it is appropriate, to ensure that these beneficial technologies do not bypass low-income and minority communities. In short, policy makers and

Hispanics will add about 6.5 million workers to the labor force from 1992 to 2005. Virtually all of these workers will be seeking jobs in the service-producing industries, such as health, education and business services, jobs that require high levels of education and computer training. Indeed, approximately 60 percent of new jobs require a working knowledge of information technology.



Many students today accept computers as "second nature," employing them to enhance their curriculum, to write papers and to "surf" the Net to gather information for research. While various public and private initiatives are underway to provide greater exposure to computer networks in many California K-12 schools, no comprehensive strategy has been implemented to achieve universal access to high-quality educational technology for the state's youth.

educators must address a basic question: Given the knowledge- and capital-intensive² nature of today's educational technology, how can private and public entities, working in unison, deliver the resources which are necessary to provide sustainable, technology-enhanced environments to America's school children, so as to maintain a competitive advantage in the global marketplace?

The Federal Government

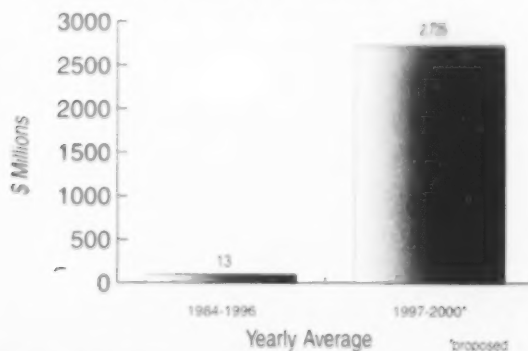
Many voices in the federal government have articulated a vision for technology development in which the public schools play a major role. In his 1996 State of the Union address, for example, President Clinton stated that "every classroom in

America must be connected to the information highway, with computers, good software, and well-trained teachers." What is striking about the president's reference to technology development is that he not only underscored the need for schools to obtain more hardware and software but also stressed the need for professional development, the latter being an essential component of meaningful technology access for our children.

What is little known is that despite the fact that education is primarily a state's responsibility (i.e. 39% of California's general fund expenditures in 1995-96 went to K-12 education), about one-third of technology funding for schools comes from federal sources.³ The Elementary and Secondary Education Act (ESEA),⁴ reauthorized in 1994 as the Improving America's Schools Act, provides a rich array of support for education technology and related projects. According to the Office of Technology Assessment (OTA), for example, over one-half of ESEA Title I projects use educational technologies, primarily computers.⁵ Bilingual and Migrant Education funding (ESEA Title VII) are also tapped by school districts and schools to fund technology development. At Greenwood Elementary School in Montebello, California, for example, teachers are attending conferences related to language acquisition through technology using Title VII funding. The extensive staff development will ultimately assist the 54 percent of the student body that is Limited English Proficient (LEP) both to acquire a second language and to learn important computer skills.

Another important development in the federal arena is the recent passage of the Telecommunications Act of 1996. Stating that "elementary and secondary schools and classrooms . . . should have access to advanced telecommunications services,"⁶ the Act offers an opportunity for schools to receive discounted rates for **advanced telecommunications services**. While this sounds straightforward, it is currently difficult to define what advanced services, if any, need to be maintained by federal support mechanisms. Many schools and classrooms still lack basic telephone connections. The introduction of upgraded, digital connection such as ISDN, as well as microwave and other wireless transmissions,

Figure 1.1 State spending on technology



would allow teachers and students to engage in two-way interactions, of voice, video, and data. The Federal Communications Commission (FCC) will ensure that schools receive advanced communication services, however defined, "at rates less than the amounts charged for similar services to other parties," according to the Snowe-Rockefeller provision of the Telecommunications Act.

California-Wide Initiatives

At the state level, the 46-member California Education Technology Task Force (CETTF) released a report in July 1996 announcing a plan for upgrading the state's education technology infrastructure, moving the state to within reach of the top ten percent in its student-to-computer ratio by the year 2000. Responding to the fact that California ranks near the bottom both in Internet access and students per computer, the report calls for \$10.9 billion to be spent between 1997 and 2000, or \$2.725 billion per year, to raise the student-to-computer ratio to four to one, to provide for staff development and support, as well as to allow for the acquisition of the **courseware** or content students will need to improve performance.⁷

The CETTF's plan would increase significantly what the state has annually spent on technology over the past decade. The state legislature invested close to \$170 million in educational technology development between 1984 and 1996, hardly sufficient to meet the needs of California's 5 million students (see figure 1.1).⁸ The Educational Technology Office of the California Department of Education provides grant monies (\$6 million in fiscal year 1995-96) on a competitive basis to schools that demonstrate a plan for using computers in the learning process. Finally, in the fiscal year 1995-96 budget, the legislature allocated \$50 per pupil of the education portion of the budget to be used for deferred maintenance, instructional materials or educational technology, which means that up to \$265 million could have been used for hardware and software acquisitions, training and support.

Private-Sector Initiatives

The private sector has shouldered the bulk of

support for the nation's telecommunications infrastructure. The federal government's own *Agenda for Action*, released in 1993, stated clearly that "the private sector will lead the deployment of the NII." Telecommunications firms, adjusting to a deregulated environment, are pouring tens of billions of dollars into building and deploying broadband networks to businesses and households. Many of the major telecommunications, cable and computer companies provide funding and technology—in the form of in-kind support, discounted rates and grants—to allow schools to upgrade their infrastructure. While these contributions to education are consequential, they represent only a small part of the costs spent so far on instructional technology.⁹

Promoting Public Goods in a Market-Driven Economy

According to many non-profit organizations engaged in telecommunications-related issues,¹⁰ there are many "public interest principles"—such as universal service and the rapid deployment of advanced telecommunications services into schools, libraries and community centers—with which the government needs to stay involved in order for these principles to be safeguarded. The argument most often heard within the third sector to support this position is that there are some public goods that the private sector will ignore, since industry will not receive a return on its investment.

Even the economist Adam Smith noted that many public goods such as those which "facilitate the commerce of the society" and "promote the instruction of the people" could not be built and taken care of by the market alone, because they are seldom profitable ventures.¹¹ As has been suggested,

As of 1995, fifty percent of all U.S. schools were connected to the Internet, up from 35 percent the year before. The growth of the intranet, or the networking within facilities, has also experienced growth, with 85 percent of schools connected to some kind of network in 1995, compared to 75 percent the previous year.

the stance of the government vis-à-vis the development of the NII, at least since 1993, has been to steer when necessary, while leaving the heavy rowing to the private sector. Many organizations within the non-profit community tend to support this position.

One example of the public interest principles to which we have alluded was recently illustrated in FCC Chairman Reed Hundt's description of the continued government involvement in communications as protecting certain "eternal verities," such as "keep[ing] on the network everyone whom society wants on the network."¹² Who will advocate to ensure that predominantly minority and low-income school districts receive necessary and meaningful telecommunications services?

Embarking on the Wiring of K-12 Schools

With a variety of public and private ventures and partnerships underway, there are signs that information technology is finally reaching the nation's schools, albeit in fits and starts. As of 1995, fifty percent of all U.S. schools were connected to the Internet, up from 35 percent the year before.¹³ The growth of the *intranet*, or the networking within facilities, has also experienced growth, with 85 percent of schools connected to some kind of network in 1995, compared to 75 percent the previous year.

The rate of spending on instructional technologies has witnessed dramatic increases over the past several years. Schools in the U.S. will spend approximately \$4 billion in 1995-96 to provide greater access to hardware and software to their students, teachers and staff, twice what it was in 1991-92 and twice what they are spending on textbooks.¹⁴ What is more, there are now 5.8 million computers for use in instruction in the U.S.—about one for every nine students.¹⁵

While these statistics show steady gains in school's acquisition of technology, one-half of the nation's schools remain without Internet connectivity. More fundamentally, the overwhelming majority of classrooms are without access to the outside world, with only one teacher in eight having a telephone in his or her class to make outside calls.¹⁶

The Cost of Meaningful Technology Access

The cost of moving multimedia computers and other valuable instructional tools closer to the fingertips of students is high, although not insurmountable. One estimate puts the cost of linking each school in the nation to an information infrastructure at \$9.4-22 billion in one-time costs, with annual maintenance costs of \$1.8-4.6 billion.¹⁷ Another report, issued by the RAND Corporation, suggests that the cost of providing the nation's schools with a "technology-rich environment" would amount to annualized costs of \$8-20 billion.¹⁸ The California Education Technology Task Force report outlines costs *to the state of California alone* at \$2.725 billion per year over four years, substantially higher than both the Department of Education-sponsored study and the RAND report. Whether our political leaders accept low estimates (e.g., which would bring California up to the national average in computer density and Internet access) or high figures, such as those offered by the CETTF report (which would elevate California to the top ten percent of states), the costs will have to be borne primarily by a skeptical public, one that thinks generally that "throwing money" at schools will not necessarily solve our educational woes.

Redefining Access

Along with thinking about how to raise the revenues necessary to fund instructional technology infrastructure in K-12 schools, educators and policy makers must also reflect on what technology access entails. By some accounts, students need only require more hardware to achieve access to the information highway. Many data-gathering organizations have adopted this thinking, collecting numerical or quantitative comparisons of hardware, such as the number of computers and televisions in a classroom or school.¹⁹

Although it is necessary to gather information on quantitative indicators of hardware that comprise technology access, it is not sufficient. Many other

factors must be taken into account before we can evaluate whether students are receiving quality or meaningful access to technology. We know that fifty percent of the nation's public schools now have Internet connectivity; however, it is not clear what this means for the caliber of education for students in these schools. How can a high school of 500 students benefit from one Internet connection? Only 11 percent of the teachers whom we surveyed, for example, said that computer learning leads to higher scores on standardized tests, a perception that follows not from a skepticism about what computers can do but rather from an acknowledgement that students receive only perfunctory access to computer networks, not enough to make a difference in their educational lives.

Experience tells us that two schools can have the same number of computers yet have varying levels of meaningful access, for administrators, staff and students.²⁰ A student with classroom access to a Power Mac, perhaps linked to a wide area network, can perform more sophisticated tasks than a student with a stand-alone, Apple II-series computer. The former may be able to load and utilize the latest software on CD-ROM, surf the Internet for information for class reports and projects, and use advanced multimedia features. When this student submits his or her application to college or résumé for a job, he/she will be at a decisive advantage.

A recent Office of Technology Assessment (OTA) report suggested that more factors be taken into account when policy makers are discussing computer access: "what is called for is a new way of defining access that examines the kinds of infrastructure, organizational arrangements, and other supports teachers need to use technology effectively in the classroom."²¹ TRPI's research on Latinos and technology echoes the OTA's concern to highlight qualitative variables. This study is a point of departure for addressing these factors as they affect educational technology access. Exploring twelve factors that impact the nature of technology access in the classroom, the TRPI goes beyond much of the research that has relied primarily on quantitative indicators to measure the ex-

perience of students in computer-mediated learning environments.

The Study

The Tomás Rivera Policy Institute conducted research to clarify the state of technology development in schools in San Bernardino and Los Angeles Counties (appendix A). The thrust of the study was to determine whether meaningful technology access was out of reach for those school districts in which the enrollment was predominantly Hispanic.

The study is urgent for at least two reasons. First, as has already been suggested, Hispanic students require quality access to computers in order to compete for technology-intensive jobs. As a recent U.S. Advisory Council on the NII report underscores, "fully 60 percent of jobs in 2000 will require a working knowledge of information technologies,"²² which means that those students without computer literacy will face underemployment or unemployment in the new economy.

The second reason why the report is critical relates to the recent direction of public policy in fostering public points of telecommunications access for low-income and minority communities. The rationale for public access points is that because low-income communities, in all likelihood, will not have advanced telecommunications services in the home for some time to come, they need to be provided services at accessible public places. Schools, libraries, community centers and public housing complexes will probably provide the first point of contact between Hispanics and computers. It is im-

Although it is necessary to gather information on quantitative indicators of hardware that comprise technology access, it is not sufficient. Many other factors must be taken into account before we can evaluate whether students are receiving quality or meaningful access to technology.



Access to technology for our youth must be redefined to include components such as teacher training, end-user support, and the environment in which students learn. For example, if teachers are not afforded the time to integrate technology into their curricula, then students are the losers in not benefiting from a computer-enhanced learning environment.

portant, therefore, to begin to clarify exactly how meaningful this computer access will be.

To answer these research questions, the TRPI employed several complementary methodologies.

site visits: TRPI researchers visited elementary, intermediate and senior high schools throughout the study area (appendix B). The point of the visits was to interview staff and students as well as to survey the environment in which they engaged in computer work;

interviews: administrators whose principal responsibility was educational technology were interviewed in nine districts in the region (appendix C). The interviews shed light on how high-level decision makers perceive the needs in their respective districts for educational technology;

principal survey: a questionnaire was sent out to each of the principals in the study area. The principals were asked to articulate both the obstacles preventing greater access to technology as well as the factors that enable increased computer access to students;

teacher survey: a questionnaire was sent out to a sample of teachers in three school districts. These surveys were used as the basis of a comparison study of a predominantly non-Hispanic white district and two predominantly Hispanic districts.

Our hypothesis was that schools in Los Angeles and San Bernardino Counties with high percentages of Hispanic and minority students experience lower rates of access to educational technology (understood as the sum of quantitative and qualitative variables) than schools in which the enrollment was predominantly non-Hispanic, white. This hypothesis followed from research showing that Hispanic students are disadvantaged with respect to the resources and skills needed to develop a comprehensive approach to technology in districts in which the enrollment is predominantly Hispanic.²³ Rather than merely replicating previous research, the TRPI attempted to examine qualitative indicators within the context of a more comprehensive definition of access, indicators which will be explained in greater detail in the following chapter.

Addressing these and other issues allows for a more comprehensive definition of technology access. Given the data we have collected, we are in a position to clarify the extent to which meaningful exposure to and experience with computer-enhanced learning environments remain out of the reach of Hispanic school children.

2. Aspects of Technology Access in the Schools

Educational technology has always been an integral part of the learning process. Historically, teachers and students used chalk and slate boards. According to an Apple Computer advertisement, noted author Amy Tan began writing after she had received "magical" pencils, with her name etched on the sides, for her eighth birthday. She now uses a Macintosh computer.

Today, the proliferation of high-speed computer networks presents challenges and opportunities for administrators, staff, teachers and pupils. These challenges—equal access to educational technology, adequate training and support, and a solid vision of curricular applications and pedagogy—must be met squarely in order for Hispanic and other children to have an opportunity to compete advantageously in a global marketplace. This chapter will address the qualitative and quantitative factors that were discovered to be necessary for meaningful access to technology, for teachers and students alike.²⁴

Comprehensive Technology Access

Within a more expansive definition of access, there are many factors that must be examined before we can determine whether Hispanic pupils are receiving access comparable to their non-Hispanic counterparts. Our interviews and site visits offer qualitative data to buttress our survey results. The sum of evidence offered in this report presents only a point of departure on what technology access resembles in any given classroom or school, a beginning point that only additional research can further advance.

The following factors have been identified as necessary, although perhaps not sufficient, for ef-

fective use of technology.²⁵ Clearly, each site will differ depending on local circumstances. Our contention is that the criteria discussed below should be considered and applied, when relevant, to a particular technology application.

Let us take each of these factors in turn and explain their relevance to a comprehensive approach to technology development in the schools.

1. Equitable and Universal Access to Technology

Equitable and universal access to technology refer to the exposure and experience all students and teachers gain with computers. The *universal* component of technology access means that all students need exposure to computers to gain the vital literacy they will need to compete in a post-industrial, information society. Whether students will become medical technicians, sales personnel or mechanics, familiarity with computers is essential to transfer x-ray images utilizing interactive video and personal computers, to handle computerized sales registers, and to be proficient in CAD/CAM. Thus, all students require computer literacy, just as all pupils need literacy in the "three Rs," reading, writing and arithmetic.

The *equity* component of access relates to the minimal threshold of technology required to meet recognized educational objectives. Certain "opportunity-to-learn standards," it is argued, would allow for the provision of the tools that all students need to navigate a post-industrial society. These standards are undoubtedly evolving, particularly due to the fact that product cycles of hardware and software continue to shrink as technology advances.

Is access to high-speed data transmission to allow for Internet-based activities at the level of graphical interfaces such as the World-Wide Web* an essential component of educational technology

access in the classroom? This is a question for policy makers as state and federal regulators decide on what advanced telecommunications services should be deemed necessary to empower students and teachers in the classroom. After it is decided what the immediate focus of technology implementation will be, it is still necessary to discern how equitable and universal access to this technology will be achieved, given the exigencies of today's learning environment in California's public schools. How will these technologies be paid for? And at what institutional level will hardware, software and professional development be administered?

2. Professional Development

Sufficient professional development must accompany any decision to install computer technology in the classroom, school or district. The overwhelming majority of principals and teachers whom we surveyed were unequivocal, that without the buy in from teachers as to the value of using new teaching tools, they will not be integrated into the student's learning environment. As one district administrator suggested, "teachers must be brought in hook, line and sinker; they must be shown how computers can benefit them before they can transfer these newfound skills to improve the learning environment of their students." Once teachers are invested in this new mode, which will include instructional and technical transformation, they are more likely to take advantage of the professional development opportunities, when available. A teacher trainer said, "vital to the implementation of any professional development program or method is the acceptance by staff and real support for the selected program."²⁶

3. A Vision of Curricular Applications

Envisioning how they will incorporate new software and hardware into a preexisting curriculum can be difficult for teachers without the training and flexibility needed to accomplish the aforementioned tasks. A teacher who is given a Power Mac or an Internet connection for his or her class-

room will not know automatically how to use these tools. A certain familiarity with and reliance on textbooks may create difficulty in moving toward use of other educational media. A teacher will need time to incorporate the multimedia capabilities of the computer into a lesson plan and a working knowledge of how the Internet could complement his/her class—for example, by allowing students to explore Web sites on a specific topic.

4. Time

A restructuring of lesson plans and pedagogical strategies takes time, time that many teachers do not have, constantly confronted with a host of equally salient issues. One administrator said that "with teacher training limited, you're competing with 'Say No to Drugs,' Child Abuse and other programs. There is not enough time allocated for re-evaluation of academics and retraining of teachers." Preservice and inservice training as well as workshops allow teachers and staff the space they need to reflect on the latest teaching tools and pedagogies that accompany the use of these computer technologies. During the course of a normal school day in the typical California school, teachers do not have the time to teach themselves complex technology applications, confronted as they are with overcrowded classrooms, the diversity of their student body, and a scarcity of resources.

5. Administrative Support

Backing for educational technology development from school district leadership is critical, because without vocal support from at least one administrator (as well as from at least one teacher), scarce resources will not be allocated for new hardware, software, training of teachers and user support.

Administrative support is also needed to allow for local efforts in facilitating technology development. In many circles today, for example, technology planning and strategizing for districts are moving toward site-based management in which schools direct their own development in line with their specific needs. Administrators must give the green light to these school reform efforts, where

accountability is not compromised, since technology can help facilitate the transition from more or less centralized to more decentralized decision-making processes.

6. Monetary and Resource Commitment

The preservice and inservice training needed to exploit the possibilities that technology affords are expensive; thus, "real support" is necessary to train teachers effectively. This often means bringing in experts and trainers with extensive experience into a school or district to direct staff development sessions and to train staff members. In short, the monetary and resource commitment must accompany any attempt at hardware and software acquisition as well as professional development in a school or district. Acknowledging the need for an initial front-end investment as well as annualized expenditures to maintain a school or district's technology infrastructure is a fruitful first step. As one administrator put it concerning the money chase in technology development: "what we will do is get x amount of dollars and we'll go out and buy the most hardware we can get for that because there is never enough dollars for what you want it to do." In other words, the total investment to forge technology-rich learning environments is out of reach; therefore, development is driven by funding rather than by a vision of what is desirable. To turn this around, sufficient up-front revenues are needed, perhaps from any or all of the following sources: bonding, tax increases, or a rearrangement of existing budgetary line items.

7. Educational Software or Courseware

Quality educational software and courseware are necessary to provide students the content with which they will learn. Many teachers claim that there is not enough quality software to complement their curriculum areas, particularly Spanish-language materials to meet the needs of a large portion of students in Southern California.

Another problem is holding children's attention, since they are used to Nintendo, video games, television and movies which provide youth a certain sensory experience which they come to expect in the classroom. Some teachers may want to uphold a rigid dichotomy between educational materials and entertainment, but the exhilarating "infotainment" to which children become accustomed can light a fire that will maintain their interest in school. Drill-and-practice programs, creative arts software, problem-solving programs as well as adventure and fantasy games and reference CDs can captivate young students, although this content is often expensive and requires a great deal of memory to run on a multimedia computer.

8. Functional Hardware

The issue of functional hardware relates to the proliferation of obsolete computers in the schools. According to the Detwiler Foundation, a non-profit organization which equips schools with quality donated computers, less than half of all computers currently being used in California's schools have hard drives.²⁷ The CETTF report, *Connect, Compute, and Compete*, also states that the **computer penetration rate** in California, once obsolete equipment is discounted, is one computer for every 73 students.²⁸ The outmoded computers clearly cannot support basic software applications, not to mention the sorts of graphical interfaces that are so popular today, such as the World-Wide Web.

9. Networking: Internet & Intranet

A shared communications system supporting digital communication as well as information and knowledge exchange among attached computers is known as a network. A small network serving a collection of computers in the same proximity is referred to as a local area network or LAN. If the computers are more dispersed, for example in different buildings around a school district, the network is referred to as a wide area network or WAN. Constructing a network in a school requires, among other things, premise wiring, as well as communi-

cation software, a distribution system, a local network server and an external connection.²⁹ While the benefits of internetworking have been well documented in the popular press and in advertising, affording students the ability to gather information and share ideas with cohorts from around the world, the intranet is an equally important component of school networking. The intranet is a shared communications system supporting digital communication among attached computers. Teachers could share e-mail and a Web site, for example, to transfer student portfolios, curriculum guides and pedagogic strategies.

10. Technical Support

Technical support is an often overlooked feature of successful school-wide educational technology development. Technical troubleshooting and support must be available to teachers in order to assist them with computer problems. Once a computer breaks down, it will not be fixed or upgraded if a technical support network is not in place. Support staff can also help teachers master software programs, teach them how to ftp and e-mail as well as how to create their own Web sites.

11. School Environmental Factors

Many schools possess unsatisfactory environments in which to accommodate advanced telecommunications tools, such as air-conditioned rooms, physical security and adequate electrical wiring and power. Some schools have made technology purchases only to find there were no outlets into which they could plug their computers. In short, a large number of schools in Southern California were built before the advent of networked computers; thus, schools are lacking the environmental factors that would accommodate computers in the classroom.

In El Rancho Unified School District in Pico Rivera, California, for example, a \$13.3 million general-obligation bond measure was passed in 1995 in order to, among other things, provide students with access to modern technology. However, the

district's facilities were in such disrepair that much of the monies went to upgrade roofs, walls, windows, plumbing and ventilation. A recent General Accounting Office (GAO) report found that a significant number of schools in California needed repair of such basics as roofs, windows, plumbing and electrical power and lighting.³⁰ When schools decide to spend money on infrastructure, often basic facilities repair and upgrade will be prioritized above technology acquisition, a situation that puts older, dilapidated schools at a disadvantage in providing state-of-the-art technology to teachers and students.

12. Suiting Technology to Educational Goals

The final issue is suiting technology to the educational goals that have been set. According to one administrator, a distinctive feature of districts that have really moved ahead in using technology is "sett[ing] defined goals for their students . . . [I]f you have outcomes in technology for students, then it's incumbent upon you to provide a program and provide equipment, and also to provide teacher training so you can provide for those students to hopefully reach those outcomes." Clearly, teachers and students must have the resources in order to meet predefined goals; it is not enough to set goals without providing the means to achieve them. The reverse is also true. Technology is a tool—a means to an end—and goals and performance standards are necessary against which students can be evaluated, whether or not they are using computers.

At the same time that the technology available to schools has been increasing, there has been a concomitant support from the public, educators and decision makers for education reform. In 1991, in California, for example, 1,500 schools submitted proposals to obtain planning grants for restructuring. Technology, in itself, cannot furnish the sufficient conditions for successful school reform; however, it can provide "an invitation to change," affording an opportunity for teachers, administrators and parents to foster healthy educational reform.³¹

Table 2.1

The following table illustrates how two schools would have diametrically opposed experiences with technology based on presence of meaningful technology access.

Aspects or Features of Meaningful Access	School A (less meaningful access)	School B (more meaningful access)
Equipment	50 computers	50 computers
Functional hardware	low-speed, inadequate memory to run graphical interface	high speed, adequate memory, multimedia computers
Software/Courseware	dull drill-and-practice English-only software	Quality, topical and language-sensitive software
Connectivity	no WAN/LAN access	WAN/LAN access
Student-Computer Ratio	one multimedia computer for every 73 students	one multimedia computer for every 6 students
Universal and Equitable Access	some students provided infrequent access to computers	all students provided regular, meaningful access to computers
Placement of Technology	technology located in labs behind locked doors	technology located in classroom, integrated into learning environment
School Environmental	insufficient electrical wiring, power, air conditioning, physical security, dilapidated roofs, walls, windows and plumbing	broadband wiring to the classroom; schools are new or remodeled to accommodate advanced telecommunications technology
Teacher Time	teachers have inadequate time to prepare to integrate computers into learning environment	teachers have study period to use to experiment with technology and write new lesson plans
Professional Development	voluntary, ad hoc teacher training from county or district	comprehensive, site-based training and mentoring of teachers and staff
Technical Support	user support from district or country	on-site user support
Administrative Support	administrators are unwilling to spend money and allocate resources to bring rich technology environment into classroom	administrators are technology-friendly, encouraging teachers to pursue grants and rearranging school budget to accommodate technology acquisition
School Reform	technology use is capricious and independent of school reform	technology is one basis of strategy to reform schools
Curricular Application	technology is used for "free time," drill-and-practice exercises	technology is integrated into curriculum
Sustainability	sustainability not secured due to unstable funding base	long-term sustainability of technology, based in secure funding, on-going teacher training and user support

3. Technology Access in Selected Southern California Schools

How do selected schools in Los Angeles and San Bernardino Counties address these issues when deciding to integrate technology into the learning environment? Can the addition of qualitative data give us a clearer picture of the state of educational technology in area schools?

Quantitative Indicators — Computer Penetration Rates, E-mail & World-Wide Web Access

In terms of access to technology, schools to which we sent questionnaires had on average just over three modems and 75 computers (24 of which were connected to any type of network, at least to a LAN), a number comparable to the national average of 72 computers per public school.³² About 29 percent of classrooms have telephone lines,

which means that most teachers spend some portion of the day in their classroom without access to the outside world. The computer penetration rate for schools surveyed, obtained by dividing the number of students by the number of computers, was about fourteen students per computer, significantly below the national average of nine students per computer, on par with the Los Angeles County average³³ and the state average of 16:1. In addition, one-half of schools surveyed had e-mail and about one-third (37%) could access the World-Wide Web, comparable to the national average of 46.5 percent for e-mail and 40 percent for WWW access.

These figures are illustrative of the state of technology in selected Los Angeles and San Bernardino County schools. The approximately 400 K–12 schools we surveyed have about the national average in terms of mean number of computers, e-mail access, and World-Wide Web access. However, we must place these numbers within the context of the environmental factors at play in Southern California.

Figure 3.1 Number of Computers per School

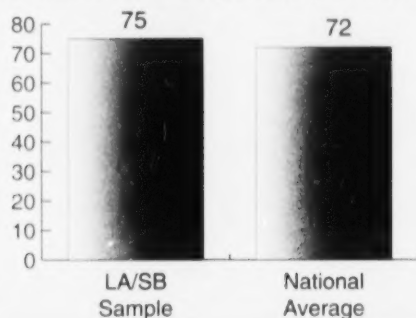
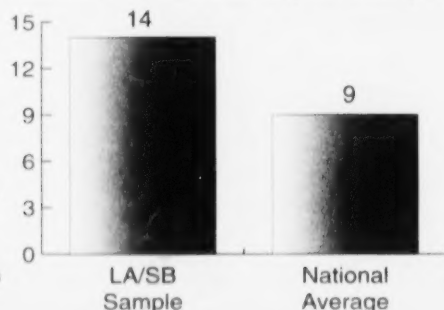


Figure 3.2* Number of Students per Computer



*All subsequent figures in chapter 3 are illustrative of teacher responses from a random survey of K–12 schools. See appendices and methodology for further details.

Qualitative Indicators — Twelve Aspects of Technology Access and the Contextual Terrain of Southern California's Public Schools

One striking example of what computer penetration rates mean in many of California's K–12 public schools underscores what is at the crux of this report—namely, to illuminate qualitative as well as quantitative aspects of technology access. Although the schools which we surveyed possess about the national average in terms of number of computers, the all-important student-to-computer ratio is much larger in our sample due to the simple fact that the student enrollment is much larger for these schools than for the nation as a whole (see

figure 3.1 and 3.2).

If we examine data for the state of California, the total public K-12 enrollment in 1995 (5 million) and the net rate of growth in enrollment over the ten-year period, 1985-1995, of 2.5 percent outpaces the ability of many districts to meet the technology needs of students. Adding 120,000 new students per year,³⁴ the state must continuously acquire computers to maintain already low student-to-computer ratios. In one school in Ontario, California the student population increased so rapidly that the computer lab was dismantled to make room for more class space, and the Apple IIs were distributed among the overcrowded classrooms. Overcrowding and expanding enrollments then are two factors of consequence to the meaningfulness of computer access in Southern California schools.

Let us examine each of the twelve aspects of technology access which TRPI has identified and describe the extent to which the school districts which we surveyed are addressing these issues.

In terms of universal and equitable access to technology, at least for the predominantly Hispanic school districts we surveyed, about one-half of teachers responded that they did not have computer access for their students in the classroom. A significant number of teachers who did not have access to computers in the classroom used either a lab or library to expose their students, however infrequently, to computer-based learning. Some students, sadly enough, had no exposure to computers. In terms of hours of instructional time, three out of four teachers responded that their pupils experienced five or fewer hours per week of instruction on the computer, hardly enough time to impact significantly the learning process, according to the majority of teachers who were surveyed. While teachers and administrators acknowledge that they need to provide greater access to computers for their students, there are many obstacles that prevent them from realizing this goal, obstacles to which we will return in the following chapter.

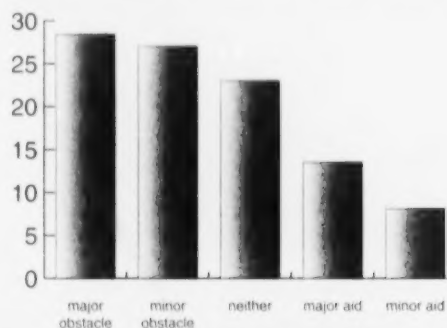
Professional development is critical for the continued success of classroom-based educational technology applications. Many teachers and staff across the nation experience inservice and



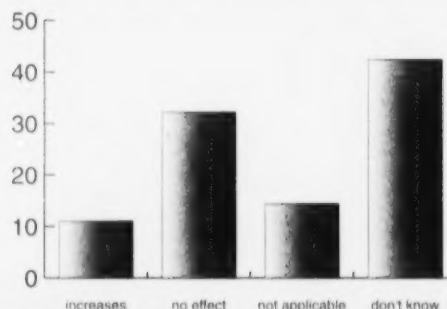
The growth in the student population in southern California combined with the high percentage of schools with inadequate facilities (i.e. roofing, plumbing, power) make it difficult for schools to concentrate funding on educational technology. School districts which have wanted to upgrade their technology, in many instances, have had to take care of maintenance, fixing broken windows and leaky roofs and have deferred buying new technology.

preservice training related to technology, but it is generally regarded as insufficient.³⁵ In our survey, as figure 3.3 reveals, only one teacher in five in predominantly Hispanic districts stated that they were aided in utilizing technology in the classroom as a

Teacher Training Utilizing Technology Figure 3.3



PC Impact on Standardized Test Scores Figure 3.4



result of the training received; many teachers recommended expanded inservice programs geared toward increasing computer literacy for themselves.

In terms of teachers' vision of curricular application, many of the respondents felt that they did not have sufficient access to educational technology in order for it to make a difference in the quality of their students learning. As figure 3.4 shows, only 10.7 percent of teachers who responded to the question stated that exposure to computers increased their students' scores on standardized tests. Three times as many instructors (31.4%) suggested that computers had "no effect," not so much due to the nature of the learning tools but rather to the quantity and quality of the access which their students experienced. While this report makes no judgment on the efficacy of computer-aided learning (versus "traditional" pedagogical tools), it is the perception of many teachers that students would fare better if they could have longer access to better software applications that are sufficiently integrated into the teacher's curriculum.

In addition, several teachers and administrators whom we interviewed had a certain vision of learning that seemed conducive to advanced classroom technology. The notion of "constructivist learning" states that teachers are more facilitators than they are instructors. The object of the computer is less to fill up kids' heads with information and more to spark their curiosity. Fifth- and sixth-graders interviewed at Oakmont Elementary School about why computers are good for them

were unanimous in liking computers—many stated that they actually enjoyed doing their work on the computer because it was fun.

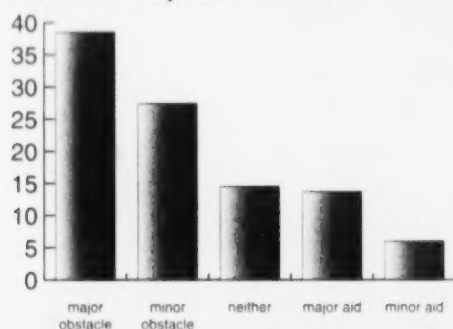
In order to incorporate technology into the curriculum, teachers said they needed more time to prepare when it came to integrating technology into their curriculum. As figure 3.5 shows, 64 percent of teachers stated that lack of time for lesson plans and pedagogical strategies was an obstacle preventing greater utilization of educational technology. The state educational technology grants (SB1510) included funding for teacher release time, explicitly acknowledging the need for teachers to expend the time outside of the classroom to discuss pedagogy, learn new approaches and share ideas.

Many of the principals interviewed stated that administrative support plays a significant role in the development of their school's telecommunications program. Over 81 percent of school principals surveyed said that district administrators played either a moderate or a large role in getting their technology plan together. Of teachers surveyed, moreover, 39 percent described the administration at their school as being an aid in the use of educational technology within their classroom. However, one teacher in four (25%) in Hispanic districts still avouched that the administration in their school tended to be more of an impediment than an aid in the acquisition of more educational technology.

As we shall see in the next chapter, sufficient money and resources remain the overriding obstacle to greater technology development. Teachers and administrators alike underscored the point that without sufficient resources, the learning environment could not be overhauled. Since computer hardware and software are capital-intensive investments, schools must be ready to outlay significant resources in order to make a dent in the way students learn and teachers teach.

A recurring issue for teachers in Southern California schools is the availability of Spanish-language software. Teachers lamented the fact that they could not obtain quality software for their Spanish-language students. In addition to finding

Figure 3.5 Teacher Preparation Time



it exceedingly difficult to find software in Spanish, many teachers just could not find software that complemented their instructional area and met their students' needs. Another issue relates to the type of software that can run on the outdated computers that many of the teachers use, computers with limited memory capacity to run today's sophisticated programs.

According to the Detwiler Foundation, the average age of a computer in California is greater than the mean student age. Students who use a computer that is as old as they are probably do not receive the exposure to the state-of-the-art learning tools they need to compete in the information society.

In addition to old hardware, many schools are faced with rooms full of stand-alone PCs which lack internetworking and intranetworking capabilities. The slogan for Sun Microsystems is "the network is the computer." While this may be overstating the case, the point of the slogan is that computers are of substantially lesser value without the ability to talk to each other, whether it be intra-site or inter-site communications.

Technical support was a problem for many teachers. Fifty-one percent of teachers stated that user support to set up and maintain their technology was an obstacle to the use of computers in the classroom. To run complicated software programs, to maintain networks, and to teach the latest protocols requires meaningful user support, without which many schools will be stuck in time, out of reach of the opportunities that expertise offers to continually update and use effectively their learning tools.

School environmental factors are critical in the schools we surveyed. Old facilities, some built in the early part of the twentieth century, present obstacles to teachers who wish to install networked computers in their classrooms. Other teachers perceived security risks, and felt that their valuable assets had to be protected, thus limiting the accessibility of the PCs.

Rapid changes in technology have been accompanied in California with general support for education reform. Linking technology with reform

has received much attention in the past several years, principally due to the fact that technology can enable students, teachers and administrators to do things differently. Technology can open up opportunities for new modes of organization, practice and pedagogy. Our discussions with administrators did not reveal great enthusiasm for radical school reform; however, several administrators suggested that technology could empower teachers, enabling them to perform their jobs more effectively.

A Comprehensive Approach To Technology Development

Examining the multiplicity of factors that contribute to improving the quality of one's educational technology environment reveals several underlying principals which educators and policy makers should not ignore. First, in order to achieve a comprehensive approach to technology development in the school, many components must be considered beyond the concern for hardware. Educators will be on more solid ground if they consider many if not all of these factors as necessary, if not sufficient, conditions to which they must attend. The experience of educators and administrators demonstrate that an ad hoc approach to technology development may be the norm in terms of practice but a more effective and sustainable approach is one that is more comprehensive.

It should be apparent by now, secondly, that most if not all of the schools from which we received surveys fell short of realizing all of the factors described in this chapter, whether it be inadequate hardware, insufficient numbers of electrical outlets, or a paucity of user support. Of course, in a world of limited time, skills and resources, experiencing contentment with the state of one's educational technology development is unlikely. There will always be new computers and software to pur-

Further TRPI analysis looking at school children who use computers in California reveals that 45 percent of enrolled Hispanic students under the age of 15 directly use a computer at school.

chase, new programs and applications to master, and old school buildings on which to make improvements. However, just because perfection cannot be reached does not discount the need to strive to improve. Understanding the obstacles to better technology-enhanced learning environments is important, since one must diagnose some of the problems before solutions can be considered. The subject of the next two chapters will include a consideration of the three major obstacles to greater technology access as well as an overview of what opportunities exist of which school districts can take advantage.

Comparing Predominantly Hispanic to Non- Hispanic Public Schools

As was suggested earlier, previous studies on computer access in the nation's K-12 public schools points to significant differences between Hispanic

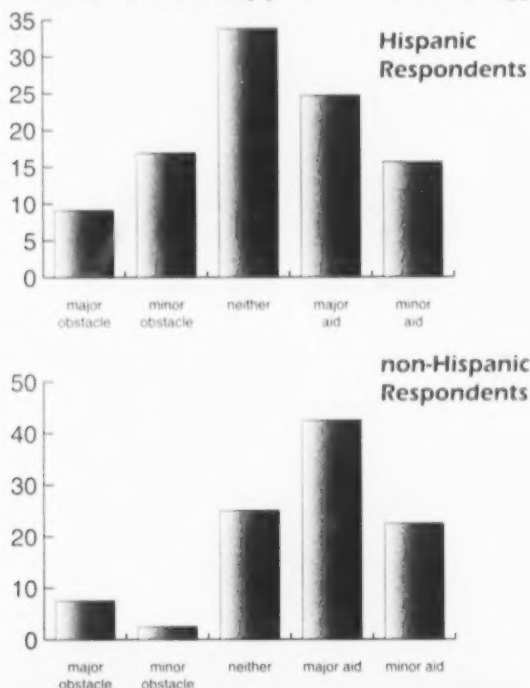
and non-Hispanic students vis-à-vis computer use. The October 1993 Current Population Survey (CPS) found that 52.7 percent of enrolled Hispanic students used computers at school compared to 62.7 percent of white students. The TRPI's analysis of this data found that this was a statistically significant difference. Further TRPI analysis looking at school children who use computers in California reveals that 45 percent of enrolled Hispanic students under the age of 15 directly use a computer at school, compared to 55.6 percent of their non-Hispanic counterparts, a statistically significant difference. The data provided by the CPS are mainly quantitative in nature, offering us a snapshot of computer use at a given point in time. The 10.6 percentage point gap between Hispanic and non-Hispanic students reveals little, however, about the quality of this access—for example, the age of the computers used, their networking capabilities, the extent to which they are incorporated into the curriculum, how often they are being used.

In order to clarify how Hispanic students are faring relative to other students in Southern California, the TRPI engaged in a case study in two predominantly Hispanic school districts and one predominantly non-Hispanic district in Los Angeles County. Bassett Unified and El Monte Union were chosen, because their student enrollment is 87 percent and 76 percent Hispanic, respectively. In addition, 58 percent of the children in Bassett Unified and 76 percent of the children living within the El Monte district boundaries are classified as living in poverty. Claremont Unified School District was chosen as the predominantly non-Hispanic district, with only 16 percent of its enrollment classified as Hispanic origin. The surveys, site visits and in-person interviews provided a wealth of information beyond raw quantitative indicators to assess what differences exist between these Hispanic districts and the non-Hispanic district.

Computer Penetration Rates

To analyze whether there are ethnic differences in computer penetration rates in the school districts which we surveyed, we compared responses from Hispanic districts to those from non-

Figure 3.6 Administrative Support for Technology



Hispanic districts.³⁶ The classrooms in the two predominantly Hispanic districts housed, on average, 33.5 students while the classrooms in the predominantly non-Hispanic district had 26.9 students. In addition, classrooms in the Hispanic sample have, on average, 2.65 computers, which means that there is approximately 12.6 students for every one computer. In the non-Hispanic classrooms, there are, on average, 2.6 computers, for a computer penetration rate of 10.3 to one. Our analysis reveals that *there is no statistically significant difference between the two mean computer penetration rates.*

The Relationship of Categorical Funding To Technology Access

One reason for the lack of difference in the most basic quantitative indicator of access (e.g., computer penetration rates) was the infusion of federal dollars into the predominantly Hispanic districts in the form of School Improvement monies, Title I funding, and even Title VII categorical dollars.³⁷ Many of the administrators who were interviewed expressed some envy toward Title I schools, since many of these schools possessed more technology than neighboring school districts where the socioeconomic status was slightly higher. While it is difficult for districts, in general, to come up with funds to spend on computers, the addition of categorical funds to schools in which a large portion of the enrollment is eligible for free and reduced lunch means that they receive additional dollars that can be spent on, among other things, technology development.

The presence of Title I funding in schools with predominantly low SES students means that the class dimension of technology in the classroom is masked.³⁸ In other words, the quantitative comparisons which have been explored, particularly as they relate to computer penetration rates, are affected by the federal subsidies that are injected into low-income schools. Without these categorical funds, the gap between Hispanic and non-Hispanic students would likely be larger, since Hispanic students are disproportionately low income.

Comparison of Qualitative Indicators of Technology Access

Some of the other factors in measuring technology access—the experience of teachers in the two samples, the learning environment in which students excel and teachers prepare and instruct, as well as the quality of software and hardware were also compared. The TRPI analysis³⁹ revealed that gaps exist between Hispanic and non-Hispanic schools in the areas of administrative support for technology development, Internet connectivity, and perceptions about security of equipment.

In the predominantly Hispanic schools—in Bassett USD and El Monte—26 percent of respondents said that administration was either a major or minor obstacle to the acquisition of more educational technology, while the figure was only 10 percent in the district with low Hispanic enrollment (figure 3.6). As we have already suggested, teachers revealed that, without administrative support for technology, scarce resources are spent elsewhere, where the perceived need is greater. Teachers who are interested in integrating technology into their classrooms must have a cooperative

Network Access Figure 3.7

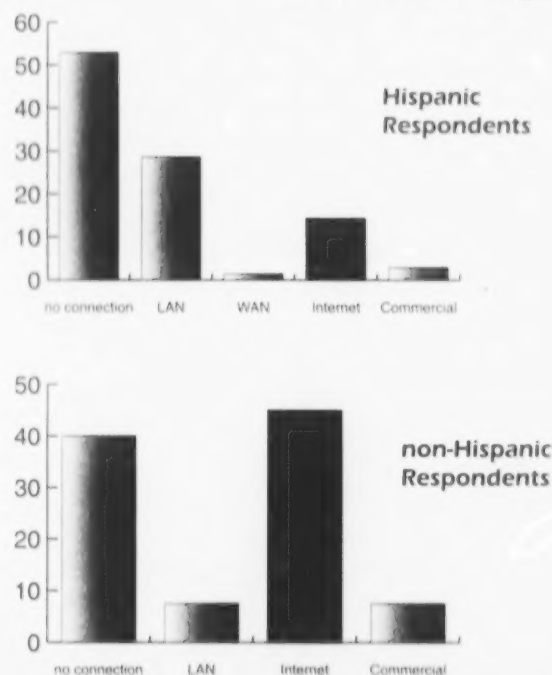
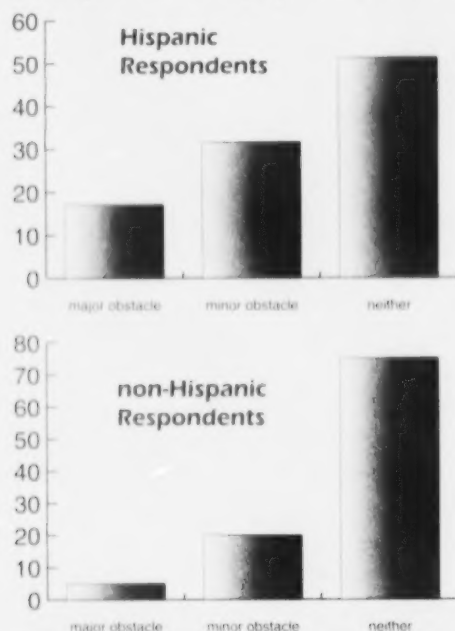


Figure 3.8 Perceptions of Equipment Security



working relationship with administrators to curry their favor for technology acquisition. Without this support, administration tends to be more of an obstacle than an aid.

Internet connectivity was also less evident in the predominantly Hispanic schools (figure 3.7). Based on teacher surveys, only 12.8 percent of classrooms in El Monte and Bassett USD had Internet access, compared to 41.9 percent of Claremont USD



The gap in technology access between Hispanics and non-Hispanics should not be gauged simply by the quantity of computers to which kids have access but also by the quality of these computers, as well as the amount of support available to cultivate a rich technology-enhanced learning environment.

classrooms, a statistically significant difference. Why is this gap important? As a recent United States Advisory Committee on the NII report noted, "in our Nation's classrooms, the Information Superhighway is being used to substantially improve the quality of general and technical education that our children receive."⁴⁰ As long as the Internet and other beneficial telecommunications services remain out of the reach of Hispanic school children, their prospects for full participation in higher education and the information economy are limited.

Finally, theft and vandalism were perceived as greater problems in Hispanic districts. As figure 3.8 reveals, almost one-half of all instructors who taught in predominantly Hispanic, low-income schools said that security was an obstacle, compared to 25 percent of teachers in the non-Hispanic white, middle-income district.⁴¹ These school districts which TRPI studied are not alone in perceiving other needs to be at least as important as providing students with more computers. As one spokeswoman for State Superintendent of Schools, Delaine Eastin, put it "there are some districts that would rather put a fence around the school to keep students safe before they would put computers in the classroom."⁴² Other districts would rather fix leaking roofs or broken windows.

These indicators show a gap in the support administration gives for technology spending, in the networking of computers, as well as in concerns over the security of expensive hardware. This study reveals three major differences in aspects of technology access between the predominantly Hispanic districts and the district in which the student population was primarily white. These problems clearly must be overcome if Hispanic students are to receive more meaningful access to advanced telecommunications services, such as Internet connectivity.

While these differences are important, the major obstacles to technology access will be explored in the next chapter. The reason they are not canvassed here is because they are near-universal problems that plague all of the school districts which we studied, regardless of race or ethnicity.

4. Obstacles to and Opportunities for Educational Technology Access

Barriers To Access

When asked to identify three hurdles to educational technology access, the refrain was often heard from principals and teachers alike that money was of overriding concern. Adequate funding, time, professional development and equipment (e.g., wiring, software and hardware) also came up again and again as reasons why schools are hamstrung in their ability to provide better resources to their students.

In arriving at these conclusions, the Tomas Rivera Policy Institute complements previous survey research on obstacles to technology advancement in the schools.⁴³ In many ways, teachers and administrators across California and the nation echo the same concerns. This chapter will focus on three of these obstacles: funding, professional development and equipment.

The common thread that unites these barriers to access is perhaps the knowledge- and capital-intensive nature of many educational technologies. Many leading-edge software programs and networking protocols are knowledge-intensive. Computer hardware is also very expensive. Both of these phenomena lead to the erection of barriers which students, teachers and administrators must attend in order ultimately to connect their pupils to advanced telecommunications services.

The Cost of Technology Access

Eighty-five percent of principals stated that money was an obstacle to the acquisition or use of advanced telecommunications in their school, while 63 percent named money as the primary (if not overriding) obstacle to greater access.

The finding that respondents are hampered by lack of funding should not come as a surprise to anybody. Educational technology—e.g., hardware, software, training and ongoing support—is expensive and demands a steep learning curve. In order to achieve an effective computer penetration rate and connectivity for students to the Internet, each site would need to appropriate significant outlays for hardware, training, support, and, in the case of most older schools, retrofitting, a state of affairs which strikes many administrators and teachers in Southern California schools as fanciful given the exigencies under which they operate. These everyday realities include: overcrowding, rising student enrollment, language diversity, security concerns, and per pupil expenditures significantly below the national average.⁴⁴

Since the budget of each school is finite, the pie must be divided among programs and commitments that each staff person believes are important. Some teachers and administrators perceive computers and connectivity to be critical for students, while others, for whatever reason, do not see these as vital to their own students' learning environment. Often times, a technology-friendly administrator or a teacher with a great deal of energy, vision and commitment can make the difference as to whether a school will purchase equipment. In sharp contrast, one who is averse to technology can derail a school's investment in educational technology in order to see that other priorities are addressed.

A recent RAND report suggested that the cost

Eighty-five percent of principals stated that money was an obstacle to the acquisition or use of advanced telecommunications in their school, while 63 percent named money as the primary obstacle to greater access.



While there are gaps between schools with a high Hispanic enrollment and schools which are principally non-Hispanic, the greatest obstacle to technology access is one shared by virtually all public schools in California—that is, the gap between what experts, practitioners and industry says *should* be spent on technology to provide our students with meaningful computer-assisted learning environments and what is *actually* being spent in the state, by government and private industry alike.

of creating technology-rich learning environments in which the student-to-computer ratio would be between three and eight students for every computer would cost between 3.2 and 8 percent of current expenditures for education. This amount would represent a three to seven-fold increase from the actual 1994-95 school year expenditures of 1.2 percent of annualized budget. The report concludes that this investment would be "modest," given the total public elementary and secondary school enterprise.⁴³

The California Education Technology Task Force figures for providing universal access to meaningful technologies are significantly higher than what the RAND report proffers. The \$10.9 billion amount, to be outlayed over four years, would represent 11 percent of the entire 1994-95 school budget. The task force report concluded that new public revenues would have to be raised, in the amount of \$6.7 billion over a four-year period, so as not to disrupt the education budget or the economy.

Certain factors—perhaps unique to California—need to be addressed by policy makers and educators if California students are to achieve a competitive advantage over students in other states. The enrollment in K-12 schools in the state

is increasing at a steady rate. Between 1994 and 1995, for example, California's public schools accommodated over 120,000 new students, a figure that represents the entire student body of the state of Wyoming, the state which ranks first in computer penetration with seven students per computer. To lower student to computer ratios would require a substantial investment in computer hardware.

Currently, California ranks near the bottom in computer penetration. There are approximately 21 students for every computer. In order to achieve a computer penetration rate at par with the national average of 9 students per computer, the state would have to make an up-front investment in 347,000 computers, and an annualized investment in approximately 13,300 computers. The CETTF report calls for a student-to-computer ratio of four to one, with six to eight networked multimedia computers in every classroom.

While much of the discussion over technology infrastructure development focuses on hardware—which is reflected in the CETTF's apportionment of over one-half of its overall budget to hardware—it is important to keep in mind that support and training, according to one estimate, comprise almost one-half of the total costs of networking schools.⁴⁴ Other substantial costs include: purchasing software/courseware and taking care of the building infrastructure, such as conduits for cables, electronic power and outlets, and air conditioning.⁴⁵ The debate over subsidizing the connection of schools should not begin and end with hammering out the best educational rates for advanced telecommunications services, a preoccupation of many groups who are trying to influence the FCC's Notice of Proposed Rulemaking (NPRM). Rather, another discussion must commence about how these connections are to be sustained and supported by trained teachers and skilled support staff.

Professional Development

Another barrier that separates schools from

greater access to technology is professional development. Teachers and staff stated that they were ill-prepared to use educational technology, to integrate it into curricula, and to invent pedagogical tools to be used in a technology-intensive learning environment. These sentiments are confirmed at the national level by recent OTA findings that "overall, teacher education programs in the United States do not prepare graduates to use technology as a teaching tool."¹⁸

One reason the issue of professional development is paramount is that computer technology and its accompanying applications undergo such frequent metamorphoses as to make mastery over them challenging. Again, changes in technology as well as its knowledge-intensive nature place strains on the inherent time limitations of staff and teachers. Many undoubtedly feel like Tantalus, in striving for competence in using the latest computer applications while coming up short due in part to inadequate ongoing inservicing. Teachers and principals whom we surveyed as well as interviewees expressed a seemingly universal theme: that they were always playing "catch up" and feared "falling behind" as technology changed the landscape around them.

Employing computers as a way to educate students has gone from programs in BASIC* and Logo* in the early 1980s to multimedia programming, Internet and World-Wide Web telecommunications in the mid-1990s. Each new generation of technology requires an investment by staff in training in order to manipulate these tools effectively for instructional use.

Ongoing professional development is necessary to mitigate the problems associated with teacher unpreparedness to meet the educational requirements of a technology-dependent age. State certification standards are beginning to take into account the need for teachers to learn computer skills, while accreditation standards for colleges of education are also undergoing revisions. What is clear is that 1.4 million new teachers will be hired between now and 2003. With sufficient professional development opportunities in place, these teachers can enter the profession with a set of skills which

they can apply to effectively incorporate instructional technology into their lesson plans. Currently, only two states require any inservice training in computers or technology for all teachers, while eighteen states mandate computer training for all teachers seeking certification. California, for instance, requires a one-semester course. The comprehensive approach to professional development is considered the most effective, while the reality is that many teachers who do receive training experience it in piecemeal fashion.

Equipment

Another formidable obstacle for educators relates to a school's equipment—hardware, software and networking—which principals and teachers perceive as being inadequate in number and in kind. Educators believe that they do not have sufficient numbers of computers for their staff and students and also suggest that they have the wrong type of technology to meet their instructional and management information needs. In short, they perceive that they are always reaching for a richer technology environment, one in which their students will be better prepared for advanced educational opportunities as well as for high-wage, high-skill jobs.

One sobering reality that adds fuel to the fire of educators' concerns involves the product lifecycle of computer technologies. The processing power of the microchip doubles at least every eighteen months, demanding the birth of new hardware and software and the simultaneous burial of the older technologies. Educators tend to think, as a result of these changes, that their school is always playing catch up to the latest technologies. Other teachers fall into inertia, since it becomes too difficult to understand and keep up with the dizzying pace of change. Updating and upgrading to faster equipment and more sophisticated software are usually too expensive for school districts to accomplish *en masse*; thus, many educators feel that they are falling behind neighboring districts or the nation as a whole in providing leading-edge instructional technologies to students and teachers.



Many opportunities exist for individual schools and districts in the form of grants both from public and private sources in order to enhance educational technology development. While many grants provide seed monies to K-12 schools, they usually do not provide the sustainability which is needed to ensure that students become literate in the most advanced computer-related applications.

Schools that invested heavily in less powerful computers to meet their needs at the time (e.g., drill-and-practice systems, curriculum-specific programs) now find them inadequate for graphical user interface and multimedia capabilities.

In addition to acquiring more computers, schools are realizing that networking computers adds tremendous value and capability to their instructional tools. The addition of the LAN, for example, allows schools to share data files and peripherals, such as printers. Approximately 20 percent of California's public schools were connected to the Internet before NetDay96.⁴⁷ Since Internet access is gaining critical mass in the schools, decisions are being made about installing wires, such

as ISDN, in the schools or even going to wireless Internet access, an option that may be preferable when installing telephone and computer cables becomes prohibitive.

While these remarks suggest general principles to follow, they belie the reality of technology development in the schools. Technology development tends to be *ad hoc* and highly correlated to the individual vision, ingenuity, drive and commitment of a single leader. While leadership often provides the impetus for change, many of the technology developments that are needed to increase meaningful access require a degree of sustainability that only institutionalizing these processes can provide.

Educational Technology Opportunities

Many opportunities exist to equalize access to educational technology, particularly for low-income and minority communities. Grants from public and private sources are transforming a small number of schools, and many states are now realizing that their future depends in large measure on building an information infrastructure to which all residents can have access. A recent General Accounting Office (GAO) report highlighted the efforts of three states, North Carolina, Iowa and Nebraska, to increase access to technology in the schools by connecting the state's public institutions to high-speed networks.⁴⁸ Private industry built the infrastructure, while each state decided to become a major customer, providing industry an income stream in order to overcome their risk-aversion to invest in this area. With its purchasing power, the state has been able to provide network use at a more affordable rate for local sites while also hastening the construction of a state-wide network. Nebraska, for example, plans to connect all elementary and high schools to the Internet by 2000. Many school districts are following suit, attempting to aggregate their demand to lower the per unit price of hard-

ware and software.

These proactive steps taken by private enterprise and state governments are being replicated throughout the country. Many localities are placing bond measures on their ballots to raise funds for technology development. An increasing number of schools are going after competitive grants in order to purchase hardware and content as well as to train staff. And schools are beginning to duplicate the efforts of successful schools in exemplary uses of educational technology in the classroom. All tolled, these opportunities provide hope to those schools which believe that leading-edge technologies will forever remain beyond their reach.

State and Federal Grant Opportunities

The Catch-22 of grant opportunities, in general, remains the fact that those who are best organized and those with the most resources tend to get the grants. There are many grant opportunities on the Internet, but who has access to the Internet? Those who are already fairly well connected. One alternative to a competitive grant process would be to provide technology funding from state and federal sources on a per pupil basis, so that no schools are left out of the rapid transition to a sustainable technology-intensive learning environment.

This transition is, in part, accomplished by programs in the U.S. Departments of Education and Commerce which are geared toward equalizing access to high-speed computer networks in general and educational applications of these technologies in particular.

Since its inception in 1994, the Telecommunications and Information Infrastructure Assistance Program (TIIAP) has provided seed money for innovative, practical technology projects throughout the United States. Providing matching monies to non-profit organizations such as elementary and secondary schools, grants are used to improve the quality of, and the public's access to education. Grantees use the money to connect to networks,

buy software, and provide for training. During fiscal year 1995, for example, the Los Angeles Unified School District received close to \$200,000 from TIIAP to provide free Internet services and computer access to students and their families, the majority of whom are minority, non-English speaking, and of low socioeconomic status. The first two years, TIIAP awards totaled \$60.1 million and expects to award over \$20 million for fiscal year 1996.

The United States Department of Education provides Challenge Grants for Technology in Education. During the fiscal year 1995 round, 19 school districts and communities in 16 states shared \$9.5 million in the first year of the multi-year, matching grants. The purpose of the challenge grants is to support communities of educators, parents, industry partners, and community leaders to retool their schools for the twenty-first century. For example, the San Diego Unified School District was among those that received federal assistance. San Diego USD is developing the "Triton Project," a multi-partner educational reform effort that blends a unique ocean-theme curriculum with several technologies to create new learning opportunities for students and teachers. Its major focus is the development of a content-based and standards-driven curriculum, stressing equitable access to technology, improved learning outcomes, improved interaction with parents and community and effective staff development.

The Educational Technology Office of the California Department of Education also awards competitive grants to K-12 schools across the state for technology development. During fiscal year 1995-96, the state awarded \$18.4 million for technology-related grants and regional staff development. One hundred twelve schools in Los Angeles County received \$3.36 million during fiscal year

1.4 million new teachers will be hired between now and 2003.

With sufficient professional development opportunities in place, these teachers can enter the profession with a set of skills which they can apply to effectively incorporate instructional technology into their lesson plans.

Technology development in the school tends to be *ad hoc* and highly correlated to the individual vision, ingenuity, drive and commitment of a single leader. While leadership often provides the impetus for change, many of the technology developments that are needed to increase meaningful access require a degree of sustainability that only institutionalizing these processes can provide.

1994-95, an average grant of \$30,000. While the grants tend to be relatively small, they are designed, as technology consultant Frank Wallace suggests, to be "readiness and capacity building." What this means is that they represent seed money, to jump start an initiative at a school and scale up as resources permit. They are unlikely to sustain a technology initiative beyond its inception.

Many schools have found creative ways to get a lot of mileage out of their grant awards. Jackson Elementary School in Whittier, for example, requested \$13,950 from the state, supplemented with School Improvement monies, to construct a writing

workshop where students, 83 percent of whom are primarily Spanish-speaking, can write, publish and edit with computers on a regular basis. Six Macintosh computers, five LC 550 with productivity pack and one AV 660, were purchased to enhance the writing process. The workshop benefits, among others, Jackson School's 230 Limited English Proficient students who can use a Bilingual Writing and Publishing Center software package to work on reports in Spanish.

The grant also included a parent education component, with parent writing sessions in the evening at which children serve as their parents' tutors. Staff development, including release time for teachers to share ideas and to implement the writer's workshop using technology, as well as training at the County Office of Education, are also integral parts of this project.

Meta-Analysis of Model Technology Programs

Educational technology centered on the networked computer is capital intensive. Buying outdated or incompatible equipment or providing insufficient user support and professional development may mean that expensive equipment will sit unused or under used. This point is underscored by a recent OTA report, which showed that while 68 percent of teachers nationwide have access to computers, only 42 percent use them as part of their curriculum.³¹ Having a technology plan may assist schools and districts to build an infrastructure that meets the needs of students and staff alike, while preventing expensive duplication of efforts or underutilization of the technology. Being able to draw from the experience of other schools or districts may also provide vital information to staff and administration, offering them ideas on how to finance their annualized expenses, to provide quality pedagogy and to use these tools to raise the level of student performance. Much more work needs to be done to identify model or best practices, applications that can be emulated in K-12 schools with similar needs. Publicizing exemplary programs in the following areas would be beneficial for teachers and administrators alike.

Successful school districts are looking to aggregate demand for hardware and software in order to reduce unit price. They are also forging alliances with private and public partners to provide valuable services. For example, working with universities or industry has provided some school districts with user support as well as Internet access, without which they would be hard pressed to maintain their networks. Investigating how districts are pooling their resources and aggregating their demand to meet the needs of their clients would be of assistance to teachers and administrators who may be thinking along similar lines.

Often times teachers receive technology in their classrooms which they do not know how to incorporate into the learning environment; it is of limited value. Effective teaching practices must be identified, using distance learning and Internet

applications, that can be replicated, particularly as they pertain to meeting the unique needs of Hispanic students.

Without buy-in from teachers regarding the use of advanced telecommunications technology in the classroom, hardware will lie dormant. It is critical that teachers and staff be trained in meeting the curricular and creative needs of their students using the Internet and in developing World-Wide Web pages. Effective professional development practices must be examined as they relate to Internet use and determine how teachers can become life-long learners to keep up with changes in technology applications.

How can students best take advantage of the limited access to the Internet and to the World-Wide Web which they are likely to receive? The way schools are organizing and positioning their hardware and software to give their students the most meaningful access to these learning tools needs to be explored in order to evaluate what architectures can best improve technology access.

The replication of sustainable instructional technology efforts can assist schools in achieving the learning environments they desire without the pitfalls which trial and error can present. To follow established and successful techniques can bring schools more rapidly up to speed in quality technology access, as long as they have the accompanying resources to put such model programs into practice.



To ensure a bright future for the children of California, a concerted campaign to end computer illiteracy is needed, one that includes children, parents, educators, policy makers, and industry players. If educational technology is viewed as a long-term investment in the future of the state rather than a short-term cost imposed on taxpayers, then this campaign may be successful and California will no longer bring up the rear in terms of access to multimedia computers and the Internet.

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Policy Recommendations

Education in California is the primary responsibility of the state government. Over the years, many grievances have been brought against states over equalization of resources among schools and districts, particularly in states in which funding is a local responsibility. One reason for the Elementary and Secondary Education Act (ESEA), passed in 1965 and partially reauthorized in 1994, was to redress these imbalances, to assure children reach high standards, "even if they are from poor families, from families which do not speak English, or who are otherwise 'educationally disadvantaged.'"⁵² Again, we are seemingly at a crossroads where states are either unwilling or unable to provide children with the technology-rich learning environments they will need to succeed in a global economy. To raise the public revenues needed to make technology access meaningful will require a concerted effort on the part of local, state and federal entities, in conjunction with private partners.

The report's basic empirical findings suggest that instructional technology is currently out of reach for many Hispanic students in California, generally, and Southern California, in particular. The inference we have made from this data is that students are ill-prepared to compete in a marketplace in which 60 percent of the jobs require a working knowledge of information technology. The basic policy recommendation following from this analysis is that students need equal and universal access to technology—such as multimedia computers and wide area networks. Although achieving technology-rich learning environments will potentially cost California billions of dollars over the next several years, such an up-front investment in our children would undoubtedly yield future returns, since the labor force would be significantly more productive. As State Superintendent of Public Instruction, Delaine Eastin, recently remarked, "It is time the state of California understands the differ-

ence between expense and investment."⁵³

This basic policy approach is embodied in the *GOALS 2000: Education America Act*, signed into law in 1994, which acknowledges the need for "opportunity-to-learn standards" that will afford all students a fair opportunity to acquire invaluable skills, including ensuring "the quality and availability to all students of . . . technologies, including distance learning."⁵⁴ Clearly, multimedia computers, connected to high-speed networks, are tools students will be hard pressed to do without if they are to have the opportunity to succeed in higher education and the economy. Keeping this context in mind, the Tomás Rivera Policy Institute recommends several action items.

i

California's political, corporate, and philanthropic leadership must be mobilized to turn credible, realistic technology plans into action Credible reports laying out how universal and equitable access to educational technology in California schools have been advanced, some complete with cost estimates. The recent California Education Technology Task Force (CETTF) report is one example. However, the political will needs to be mustered to raise the substantial public revenues which will be required to implement a comprehensive technology plan.

ii

Parents, community members, and educators must advocate heavily for comprehensive educational technology investment in K-12 schools To generate the support needed to raise funds for sustainable technology investment in the schools, public pressure must be brought to bear on elected of-

ficials to divert existing funds and to raise new public revenues earmarked for technology infrastructure development. Parent groups, community-based organizations, teacher's unions, school boards, among others, must advocate for greater spending on instructional technology in the public schools.

iii

Nurturing private-public partnerships is vital to ensure support for technology efforts Business support will be vital to ensure that meaningful technology development occurs in California's classrooms. Private-public partnerships and enterprises are vital to provide leading-edge technology as well as invaluable expertise in deciding—in consultation with educators—how technologies can best meet the educative needs of students. Notwithstanding current private sector involvement in the schools, much more can be done by business and industry to bring an enhanced technology environment to students.

iv

The state of California could become a major telecommunications-services customer in order to more rapidly connect the state to a high-speed network In order to create technology-rich learning environments in California's schools, one approach might be for California to become a major customer for telecommunications firms which would network the state's public institutions. Following the examples of North Carolina, Nebraska, and Iowa, the state could connect a significant portion of its schools to a state-wide network more rapidly than if districts were to proceed piecemeal.

v

School districts, county offices and the state need to aggregate demand for hardware and

courseware to effect reduced unit price Often times it is difficult if-not impossible for particular school sites or districts to purchase hardware and software on their own or to hire a technician. The costs are prohibitive. However, if school districts, county offices, the state of California, or other interested entities were to aggregate their demand, the reduced unit price of technology wares would allow for increased purchasing power. In addition, school districts can pool their resources to share technical support and Internet access providers.

vi

Communities must advocate for a reduced 'e-rate' to provide low cost community access points for advanced technology Communities must attempt to persuade the Federal Communications Commission (FCC) to provide advanced telecommunications services⁶⁵⁵ at the lowest discounted rate to K-12 schools (as well as other public access points). The importance of public access points for low-income and minority communities cannot be stressed enough, since the cost of Internet access to the home is currently prohibitive for most families. Communities should convince the FCC that the so-called "e-rate" or educational rate should be as close to free as possible to ensure that there is universal and equitable access in public school rooms to the latest telecommunications tools.

Another basic finding of this report is that qualitative indicators are necessary to determine the extent to which students are gaining meaningful access to instructional technology, such as the Internet. Without this data, it will be difficult for policy makers and educators to decide how best to build California's technology infrastructure, including not only hardware but useful software and properly trained teachers. The following recommendations follow from this analysis.

vii

A more comprehensive definition of technology access is needed A broader definition of access—one that includes teacher training, technical support, connectivity, as well as content standards that provide for an ethnically and linguistically diverse school-age population—is needed to inform educators and decision makers about how to proceed in building their technology infrastructures. For too long, connectivity has been used as the *sine qua non* of access, while attention to teacher training, user support and school environment has lagged. Educators, community-organizations, and government organizations need to work with a broader definition of access in order to provide a comprehensive approach to technology development.

viii

A meta-analysis of model technology applications is warranted A clearinghouse is needed that compiles and analyzes data on model technology programs, particularly those "success stories" which are improving the learning environment of Hispanic school children. Meta-analyses must be collected of model technology programs, including how model financing, pedagogy, and training enhance student performance. Schools must also have information on leading-edge hardware and software applications and architectures as well as case studies of technology development within the context of comprehensive education reform.

ix

Data-gathering organizations should collect information on qualitative indicators that comprise technology access Qualitative data gathering is crucial to provide a richer assessment of how technology is transforming the learning environment. Research on educational technology development in the public schools must go beyond the

quantification of, say, computers per pupil or schools/classrooms with Internet access and engage in qualitative data gathering to illuminate the extent to which school children are receiving meaningful access to today's advanced telecommunications tools in the classroom setting. The U.S. Department of Census, for example, must add more questions to its Current Population Surveys that inquire into computer use in the schools to take account of a broader definition of access. The California Department of Education should also inquire whether courseware is ethnically and linguistically sensitive, given the diversity of students in the state.

Another component of technology access is spurring interest in the community, especially among parents, to ensure that they become better acquainted with computers. Hispanic adults will likely need to acquire computer skills if they are to find many of the service-related jobs that are currently in demand. Also, parents are instrumental in the educational success of their children. Those parents who take an active part in their children's education are more likely to see their children graduate from high school and go to college than those who do not. Given this scenario, the following policy options are advanced.

x

Schools must incorporate a parent education component as an essential component of their technology plans Parents can join their children before or after school in learning vital computer literacy, often with their own kids as tutors. This arrangement engenders parental interest in computers as well as greater involvement in their child's education. We might want to call this approach *family computer literacy*, and encourage its inclusion in any relevant technology grant or appropriations.

xi

The home-school connection needs to be cul-

tivated to facilitate accountability of student, parent and teacher Schools must encourage the interconnecting of home to school to allow for greater parent involvement in the educational process. Teachers could share homework assignments and student portfolios with parents to ensure greater student, parent and teacher accountability.

xii

A public education campaign is needed to spur demand for computers in the Hispanic com-

munity A public education campaign is needed, targeted at the Hispanic community in Southern California, to spur demand for computers. One approach may be to demonstrate the educational and employment benefits of having computer skills. Those households that own a computer are at a decided advantage over those without, allowing children to work on the computer while also permitting, with a modem connection, access to the Internet. Spurring demand for computers in the Hispanic community will increase the educational prospects of children while also empowering adults, fulfilling their communication and information needs.

Appendix A: Profiles of Participating School Districts

	Enrollment Percent	Hispanic Percent	Other Minority Percent	Children in Poverty
Baldwin Park	15,979	83	9	56
Bassett Unified	5,693	87	8	58
Bonita Unified	9,846	25	14	21
Chaffey Union High	15,560	42	18	8
Charter Oak Unified	6,183	32	13	17
Claremont	6,331	16	23	13
Covina Valley Unified	12,841	45	17	30
Cucamonga School District	2,400	47	19	42
East Whittier City Elementary	8,136	53	5	28
El Monte Union High	9,703	76	16	76
El Rancho Unified	10,817	93	2	59
Fontana USD	30,174	57	9	40
Hacienda La Puente Unified	21,771	64	23	28
Montebello Unified	32,022	89	7	43
Mountain View Elementary	9,147	88	9	91
Ontario-Montclair	23,132	65	13	56
Pomona Unified	30,046	68	21	48
Rowland	18,324	53	33	28
San Bernardino USD	44,250	47	25	54
Walnut Valley USD	13,423	18	49	2
Whittier City Elementary	6,290	80	4	54
Whittier Union High	9,807	67	6	8
TOTAL	341,875	61 (206,842)	18 (61,068)	40

Appendix B: List of Sites Visited

Los Angeles Senior High School
 Lydia Jackson Elementary
 Serrano Middle School
 Bassett USD sites
 Claremont sites
 San Bernardino sites
 Ontario sites

Appendix C: List of Participants in In-Person Interviews

Richard Archibald-Woodward
Ontario-Monclair

Linda Bonafel
Walnut Valley USD

Chris Ericson
Rowland USD

Dr. Dan King
San Bernardino USD

Margaret Lutz
Director of Instruction
Bassett USD

Arthur Narvaez
Assistant Superintendent, Operations/Support Services
El Rancho USD

John Roach
Assistant Superintendent, Educational and Personnel Services
Charter Oak USD

David Rose
Claremont USD

Olivia Simpson
Instructor
Claremont USD

John Staulmont
Instructor
Ontario-Montclair USD

Frank Wallace
Consultant
Educational Technology Unit, California Department of Education

Steve Yukhno
Montebello USD

Methodology

The Tomás Rivera Policy Institute has undertaken an analysis of the state of technology development in parts of Los Angeles and San Bernardino Counties, supplemented by state and national data on computer access in K-12 public schools. The 22 school districts listed in appendix A were chosen because the TRPI has developed a working relationship with many of them. The TRPI has partnered with many of the districts in developing a joint government grant proposal over the past two years. The importance of a preexisting relationship is important with school districts, since without the cooperation of administrators, it is difficult to gain the attention of principals and teachers, particularly as it relates to filling out and returning surveys. Since we were interested in gaining data on the qualitative indicators which comprise meaningful technology access in the classroom, the established relationship with the districts was critical to probe teachers, principals and administrators about an array of issues.

Three complementary methodologies were used to understand better the issues, problems and concerns of practitioners in area schools.

1. Surveys of Principals and Teachers

Surveys were sent to principals and teachers to gauge their attitudes toward educational technology. A survey was sent to every principal within the study area. Of the 382 principals who received a survey, 54 were eventually returned, or 14 percent. To determine the degree to which we could generalize to the entire population from the 14 percent of the surveys that were returned, standard errors were calculated. The TRPI was 95 percent certain that these surveys represented the attitudes of area principals (the population percentage) within plus or minus 4.7 percent.³⁶ The brief survey included the following eleven questions:

1. For each type of technology, please provide the total number of units available at your school for instructional use: a. total number of computers; b. computers with modems; c. networked computers; d. network servers.

2. Does your school have plans to make any major technology purchases in the near future? (Yes-elaborate/no)

3. What Internet capabilities does your school have—e.g., electronic mail, resource location services, world-wide web?

4. Approximately what percent of classrooms in your school have phone lines?

5. Please check the box that best indicates the extent to which the following groups have played a formal role in developing your school's telecommunications program? a. students; b. teachers/staff; c. district administrators; d. local business leaders; e. corporations; f. institutions of higher education; g. community organizations; h. state educational agency; i. other.

6. What percent of your school's budget is spent on technology procurement and support for this fiscal year, 1995-96?

7. Approximately what percent of teachers at your school have spent time training in how to use computers in the context of classroom teaching?

8. What are the top three obstacles to either the acquisition or the use of advanced telecommunications at your school?

9. What are the top three factors that facilitated the acquisition of the use of advanced telecommunications?

10. What areas of student learning do you believe have been improved by the introduction of instructional technologies at your school?

11. If you have any ideas or comments on the state of educational technology in your school, please elaborate below.

The teacher survey was sent out to selective

districts, ones that showed a remarkable willingness to assist us in reaching teachers. We chose one predominantly non-Hispanic district and two predominantly Hispanic districts. Claremont USD is 84 percent non-Hispanic, and the median household income in the city is \$53,479. The majority-Hispanic districts chosen, Bassett USD and El Monte USD are 87 and 76 percent Hispanic, respectively. The 1989 median household income is \$33,273 for La Puente and \$28,034 for El Monte.

Of the 1,033 teachers in the three districts who could have received surveys, 123 were returned, or 12 percent. Seventy-eight responses were from the two predominantly Hispanic districts, El Monte USD and Bassett USD. Using the same formula for determining standard error for the principal survey, the TRPI found that the attitudes and responses in the survey were within 2.9 percent of the population percentage with 95 percent probability (see footnote 58). The teachers were asked the following questions:

1. How many students are in your classroom?
2. Do your students have access to a computer at school?
3. Where do your students do most of their computer work while in school? a. classroom; b. computer lab; c. library or resource room; d. administrative office.
4. What kind of (and how many) computer(s) do your students use?
5. Is the computer your students can access at school connected to a. not connected; b. local area network; c. wide area network; d. Internet; e. commercial network?
6. What type of network connection do you have? a. modem; b. T1; c. 56Kb; d. SLIP/PPP; e. ethernet.
7. Approximately how many hours per week do your students use computers for instruction, recreation, or other applications while in school? a. do not use computers; b. 1-5; c. 6-10; d. 11-15; e. 16-20; f. 20+.
8. Based on your experience in the classroom, how has the introduction of instructional technologies (especially computers) into students' learning activities affected the following (increased/de-

creased/no effect/not applicable/don't know)? a. scores on mandated tests; b. opportunities for collaborative learning; c. opportunities to work independently; d. understanding of math and sciences; e. access to information; f. communication with the outside world; g. self-esteem; h. exposure to basic computer applications; i. critical thinking and analytical skills; j. employability; k. communication between teachers and parents; l. instruction of LEP students.

9. To what extent do the following now stand as obstacles or aids to the acquisition or the use of advanced telecommunications? a. equipment; b. hardware upkeep and repair; c. access to equipment; d. instructional software; e. administration; f. other teachers; g. parents; h. students; i. teacher training in utilizing technologies; j. user support to set up and maintain technologies; k. teacher preparation time; l. theft and vandalism; m. school infrastructure; n. corporate partnerships; o. conferences/workshops.

10. Of the above, which is the greatest obstacle and/or aid to either the acquisition or the use of computers?

11. How many years of computer experience do you have? a. do not use computers; b. less than 1; c. 1-5; d. 6-10; e. 11-15; f. 15+

12. How were you trained? a. self taught; b. college course; c. inservice training; d. on-site consultants; e. conferences or workshops; f. teacher credential program; g. courses offered over the network; h. instruction from colleagues.

13. Please check if your classroom is one of the following? a. mainstream classroom; b. migrant education; c. special education; d. GATE; e. Bilingual/ESL; f. EDY.

2. In-Person Interviews of District Administration

Interviews were conducted of district administrators as well as some teachers and principals in the fall of 1995. All tolled, twelve 30-minute to one-hour interviews were conducted (see appendix B for list of interviewees). District administrators were asked the following questions:

1. What kind of technology infrastructure is

your district involved in building?

2. What specific technologies are you interested in purchasing and what aims or needs are these tools meant to address?

3. Does your district have a technology plan? If not, what is your vision of the purpose of educational technology in the lives of students as we move into the twenty-first century?

4. How do you perceive your district relative to other districts in Southern California with respect to technology development?

5. What percent of the district budget is spent on technology development, both hardware/software and teacher training/preparation?

6. How is the decision made concerning what monies will be spent on? Who is involved in the process?

7. Have you pursued grants from state, federal, or corporate entities for technology development? How helpful have corporations been in the development of your district's technology infrastructure?

8. How much coordination is there with respect to technology development between the district and the school? How about between districts? With the county?

9. How have you developed technology applications that serve all students? Are there special focuses for educational technology, such as vocational education, language development or advanced placement activities?

10. Have you come across any serendipitous uses or affects of educational technology that you hadn't thought of before you introduced it?

11. How have teachers been trained to inte-

grate these learning tools into the curriculum?

12. Is your district networked? What sort is it? What do you use it for?

13. If you had to rank the top priorities of your district in terms of your mission, where would technology rank in importance?

14. What are the biggest obstacles to technology development in your district?

15. Approximately what percent of your students have computers at home? How does this affect their ability to master computer applications and compete with their cohorts in other districts?

16. Do you envision schools playing a role in equalizing access between the haves and have-nots in, for example, the development of computer literacy?

17. Are there model or exemplary schools or teachers in your district that are doing innovative things with computer-mediated learning?

18. Are you trying to replicate these programs at other schools in your district?

Site Visits to Selected K-12 Schools

Site visits were conducted at various elementary, middle and senior high schools throughout Eastern Los Angeles and San Bernardino Counties. We were most interested in viewing the primary computer facilities which tended to be libraries, labs and some classrooms. We asked the staff person who was interviewed about the type of equipment used, the environment in which students learned, and the amount of time and exposure students received at the computers.

Glossary

Advanced Telecommunications Services: functional applications that should be considered for schools and libraries at discounted rates, such as high-speed circuits for data transmission, video conferencing, video on demand, interactive multimedia, and Internet-based activities at the level of graphical interfaces.

BASIC (Beginner's All-Purpose Symbolic Instruction Code): A common programming language.

Broadband Network: refers to any communications transmission facility that has a capacity significantly greater than a voice-grade telephone line. Broadband facilities may carry numerous voice, video and data channels at once.

Computer Literacy: traditional literacy is defined as the ability to read and write, thought to be the building blocks of communicating in a culture centered on the written word. With the rise of computers as a fundamental means of communicating, conducting commerce, etc., it is believed by many that a familiarity with computers is crucial to be literate in a culture more and more reliant on the networked computer.

Computer Penetration Rate: also called student-to-computer ratio, the computer penetration rate refers to the number of students per computer in a school. For example, if a school of 200 students also contained 20 computers for instructional use, the computer penetration rate would be 10:1, or 10 students per computer.

Courseware: a package used for teaching and learning that includes computer or video software and related print materials such as a teacher's guide and student activity book.

E-mail (Electronic Mail): written messages (sending or receiving) transmitted across networks and usually accessible only by the addressee by using an online mail user agent.

FTP (File Transfer Protocol): A standard technique for transferring files among dissimilar computer systems on a network.

Internet: a widely used public computer network, initially developed by the U.S. military, linking computer networks and allowing computer users on different electronic-mail systems to communicate with one another around the globe.

Intranet: a shared communications system supporting digital communication among attached computers. Intranets can be used in offices or schools to connect workers or school staff to facilitate sharing of information. Those on intranet can connect to Internet. Those on Internet cannot connect to (proprietary) intranets.

ISDN (Integrated Services Digital Network): is an enhanced, digital telephone service that operates on copper wire and permits voice, video and data simultaneously.

LAN (Local Area Network): the linkage of computers and/or peripherals (e.g. printers) confined to a limited area that may consist of a room, building, or campus that allows users to communicate and share information.

Multimedia: any combination of video, sound, text, animation, and graphic images in a computer-based environment. Often includes technology such as CD-ROM, videodiscs, videocassette recorders, television, video cameras and software.

NII (National Information Infrastructure): the so-called "information highway" can be described as the physical facilities used to transmit, store, process, and display voice, data and images as well as the means to integrate and interconnect these physical components.

Technology-rich classroom environments: cutting-edge classrooms in which the needs and capabilities of students are being met through use of technology. The characteristics of these classrooms include, but are not limited to (1) the density of computers far exceeds that which is common in schools today (2) goals for student outcomes are clearly understood (3) teachers and adminis-

trators were committed to technology development, including restructuring of "normal" school day, and increasing school budgets for technology.

WAN (Wide Area Network): a data communications linkage designed to connect computers over distances greater than the distance transmitted to LANs (building to building or city to city), that allow users to communicate and share information.

WWW (World-Wide Web): A hypermedia information retrieval system linking a variety of Internet-accessible documents and data files (text and graphics).

Endnotes

1 Information Infrastructure Task Force, *The National Information Infrastructure: Agenda for Action*, September 15, 1993.

2. Capital-intensive refers to anything that requires a large investment in money or equipment. The average cost of a computer, for example, is about \$2,000, quite expensive, especially for public schools, which must already spend scarce resources to mitigate a host of problems. Knowledge-intensive means something that requires a great deal of training, skill or know-how. Finally, technology-intensive activities refer to those processes wherein computer-related technologies are a critical component. The workplace, for example, is becoming technology-intensive, since at least one-half of all new jobs require some form of technology literacy. Therefore, schools must keep pace to teach students valuable skills for the jobs of the future.

3. Thomas L. Glennan and Arthur Melmud. *Fostering the Use of Educational Technology: Elements of a National Strategy*. Santa Monica, CA: RAND, 1996. See page 65f.

4 The Improving America's Schools Act of 1994, which reauthorized most of the Federal Government's programs under the ESEA, provides assistance to states and local school districts for K-12 education in order that all students achieve high standards.

5. U.S. Congress, Office of Technology Assessment. *Teachers and Technology: Making the Connection*. Washington, D.C., 1995.

6. See *Telecommunications Act of 1996*, section 254(b6).

7. The California Education Technology Task Force, *Connect, Compute, and Compete*. Sacramento, 1996.

8 To illustrate what a small investment the state has made in technology development over the past decade relative to what the CETTF report calls for, the annual expenditure on technology between

1984 and 1996 is \$13 million or less than one percent of the \$2.725 billion annualized costs which the state task force believes to be necessary to provide technology-rich learning environments for K-12 students.

9. Lewis Solomon. "The Last Silver Bullet: Technology Can Save Our Schools," unpublished manuscript. Milken Institute for Job & Capital Formation. Santa Monica, CA, 1995.

10. Some of the non-profit organizations to which I am referring are the Benton Foundation, the Alliance for Public Technology and Computer Professionals for Social Responsibility, each of which has its own Web page.

11. Smith suggests that it is the duty of the commonwealth to erect and maintain public works that are advantageous to "a great society" but which "are of such a nature that the profit could never repay the expence to any individual or small number of individuals." In *An Inquiry Into the Nature and Causes of the Wealth of Nations*, Book V, Chapter I, part 3.

12. Reed E. Hundt. "The New Paradigm and Eternal Verities in Communications," *Jobs & Capital* 4 (summer 1995): 39-42.

13. U.S. Department of Education, Office of Educational Research and Improvement. *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools*, 1995. Washington, D.C., 1996.

14. Quality Education Data, QED Quarterly, Winter 1996.

15. *Teachers and Technology* 1.

16. *Teachers and Technology* 77.

17. U.S. Department of Education. *Connecting K-12 Schools to the National Information Infrastructure: Technology Models and Their Associated Costs*, by Russell Rothstein. Washington, D.C., 1994.

18. *Fostering the Use of Educational Technology*, see chapter 3 for cost estimates and chapter 2 for

definition of "technology-rich" learning environment.

19. A recent report released by the National Telecommunications and Information Administration, entitled *Connecting the Nation: Classrooms, Libraries, and Health Care Organizations in the Information Age*, suggests that the most current data regarding Internet connectivity is the central benchmark for NII access. This report suggests that while Internet connectivity is necessary, it is not sufficient to provide customers with quality access to needed services.

20. For greater clarification of what meaningful technology access entails in two schools with the same number of computers, see *Latinos and Information Technology*, chapter 3, especially table 1.

21. *Teachers and Technology* 122.

22. The United States Advisory Council on the National Information Infrastructure, *KickStart Initiative: Connecting America's Communities to the Information Superhighway*. Washington, D.C., 1996.

23. U.S. Congress, Office of Technology Assessment. *Analysis and Trends of School Use of New Information Technologies*, by Henry Jay Becker. Washington, D.C., 1994. The U.S. Bureau of the Census, *Current Population Survey* (October 1993) also reveals that Hispanic children enrolled in school use computers at a rate lower than their White counterparts (52.7 versus 62.7 percent).

24. It is recognized that listing necessary conditions for technology development in the schools does not negate allowances for local conditions. The variables discussed are explained in a general sense, and it is granted that successful technology development in the public schools can take many shapes and sizes.

25. Some of these requirements were borrowed from Jane L. David, "Realizing the Promise of Technology: A Policy Perspective," 177ff. In *Technology and Education Reform*, ed. Barbara Means. San Francisco: Jossey-Bass Publishers, Inc., 1994.

26. Dennis R. Lauro, Jr. "Five Approaches to Professional Development Compared." In *Technology Horizons in Education Journal* 22.10 (May 1995): 61-65.

27. Information available from the Detwiler

Foundation home page at <http://www.thegroup.net/detwiler/intro.htm>.

28. According to Quality Education Data, the number of students per multimedia computer in California is 52:1. Cited in *Los Angeles Times* (D1), "Computers in Schools: A Report Card." 26 August 1996.

29. For a more detailed analysis of networking in the schools, see California Department of Education, *Building the Future: K-12 Network Technology Planning Guide*. Sacramento, 1994.

30. United States General Accounting Office, *School Facilities: Profiles of School Condition by State*. Washington, D.C. 1996.

31. See the excellent articles on technology and education reform in Barbara Means, ed. *Technology and Education Reform: The Reality Behind the Promise*. San Francisco: Jossey-Means, 1994.

32. *Advanced Telecommunications* 10.

33. The Los Angeles County Office of Education released a "report card" in July and found that there were 14 students for every computer in the county. See Richard Lee Colvin. "Schools Catching Up on Computers." In *Los Angeles Times* (B1), 17 July 1996.

34. California Department of Education, Educational Demographic Unit, April 1996.

35. Sixty-two percent of public schools nationwide said that a lack of or inadequately trained staff was either a moderate or a major obstacle to the acquisition or use of advanced telecommunications. See *Advanced Telecommunications* 19.

36. In order to show if there are statistically significant differences between the Hispanic and non-Hispanic respondents, a t-test for independent samples was done, allowing one to compare means from two unrelated samples. In this instance we want to determine whether the two samples (predominantly Hispanic school district responses/predominantly non-Hispanic school district responses) have the same mean. A mean is an arithmetic average. For example, the mean number of students in the following three classrooms with 18, 20, 22 students, respectively, would be 20. To determine statistically whether a sample with a mean of 33 students is significantly different than an independent

sample with a mean of 27 students requires an analysis that requires that the population variances are equal.

37. These findings have been demonstrated nationally in Becker's *Analysis and Trends* 51 n. 2. The QED data he quotes shows that schools with more than 50% Chapter I eligible students have, for example, 29% more computers per capita than the average elementary school.

38. This observation was made by Dr. Gary Segura, Associate Professor in the Center for Politics and Economics at the Claremont Graduate School.

39. Differences in the qualitative data were analyzed using the Chi-Square Test, used to test hypotheses about the proportion of cases falling into several mutually exclusive groups. For example, the Chi-Square distribution will calculate whether the counts in each box (e.g., responses to Likert scale questions) diverge significantly from what would be expected by chance.

40. The United States Advisory Council on the National Information Infrastructure, *A Nation of Opportunity: Realizing the Promise of the Information Superhighway*. Washington, D.C., 1996.

41. The following variables were statistically significant when a Chi-Square Test was conducted between Hispanic and non-Hispanic districts: administrative support, $n=82$, $p=.02208$; network access, $n=83$, $p=.00745$.

42. Quoted in the *San Francisco Examiner*, "In California, Doubts About NetDay96 in Schools," by Tom Abate, 12 March 1996.

43. See U.S. Department of Education. *Telecommunications and K-12 Educators: Findings from a National Survey*, by Margaret Honey and Andrés Henríquez. Washington, D.C., 1993; *Advanced Telecommunications*, 1996; *Teachers and Technology*, 1995.

44. California's per pupil spending in 1994-95 was \$4,731, 42nd in the nation and 20% below the national average of \$5,894.

45. *Fostering the Use of Educational Technology* 58.

46. Russell I. Rothstein. "Architecture and Costs of Connecting Schools to the NII." In *Technology Horizons in Education Journal* 23.3 (October

1995): 91-96.

47. See *School Facilities*, especially appendices III and V.

48. *Teachers and Technology* 184.

49. Quoted in "Doubts About NetDay96."

50. U.S. General Accounting Office. *Telecommunications: Initiatives Taken by Three States to Promote Increased Access and Investment*. Washington, D.C., 1996.

51. Quoted in *KickStart Initiative* 28.

52. See *Improving America's School Act of 1994*, summary.

53. See "Schools Catching Up on Computers" B3.

54. See *GOALS 2000: Educate America Act*, section 213.

55. For an informative summary of comments to the FCC proceedings on Universal Service regarding schools and libraries, see the Benton Foundation's WWW site at www.benton.org.

56. It must be kept in mind that self-selection is always a potential problem with survey methodology. That is, those people most likely to return a questionnaire likely have a different outlook on technology than those who are less likely to fill out a survey and return it. Those principals and teachers with no knowledge or interest in computers, for example, are not as likely to return a survey as those who are very interested, heavy users of computers.

$$SE(p) = \pm \frac{\sqrt{(.14)(.86)}}{54} = \pm 4.7\%$$

From the total population of principals ($N=382$) within our 22 school districts, 54 surveys were returned ($n=54$) or 14 percent. To determine the standard error for the population ($SE(p)$), we took the percent of the population surveyed (14%) to arrive at a standard error of 4.7% at the 95% confidence level. The same calculation was performed for the teacher surveys. 123 teacher surveys which were returned from a population of 1,033 or 12%. The standard error for the teachers survey was calculated as $SE(t)=2.9\%$.

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The following individuals provided important feedback on this project from start to finish, assisting in everything from its conceptualization to the methodology to commenting on the findings.

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